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LIST OF MEETINGS AND PAST OFFICERS

First Annual Meeting, Washington, D. C., Nov. 12–14, 1889. President, C. V. Riley; Vice-President, S. A. Forbes; Second Vice-President, A. J. Cook; Secretary, John B. Smith.

Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

Third Annual Meeting, Washington, D. C., Aug. 15–18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wis., Aug. 14–16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey; Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27–28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio, Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Colo., Aug. 23–24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins; Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburgh, Pa., June 27–28, 1902. President, A. D. Hopkins; First Vice-President, E. P. Felt; Second Vice-President, T. D. A Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27, 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

Seventeenth Annual Meeting, Philadelphia, Pa., Dec. 29–30, 1904. President, A. L. Quaintance; First Vice-President, A. F. Burgess; Second Vice-President, Mary E. Murtfeldt; Secretary, H. E. Summers.

Eighteenth Annual Meeting, New Orleans, La., Jan. 1–4, 1906. President, H. Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. E. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28–29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27–28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

Twenty-first Annual Meeting, Baltimore, Md., Dec. 28–29, 1908. President, S. A. Forbes; First Vice-President, W. E. Britton; Second Vice-President, E. D. Ball; Secretary, A. F. Burgess.

Twenty-second Annual Meeting, Boston, Mass., Dec. 28–29, 1909. President, W. E. Britton; First Vice-President, E. D. Ball; Second Vice-President, H. E. Summers; Secretary, A. F. Burgess.

Twenty-third Annual Meeting, Minneapolis, Minn., Dec. 28–29, 1910. President, E. D. Sanderson; First Vice-President, H. T. Fernald; Second Vice-President, P. J. Parrott; Secretary, A. F. Burgess.

Twenty-fourth Annual Meeting, Washington, D. C., Dec. 27–29, 1911. President, F. L. Washburn; First Vice-President, E. D. Ball; Second Vice-President, R. H. Pettit; Secretary, A. F. Burgess.

Twenty-fifth Annual Meeting, Cleveland, Ohio, Jan. 1–3, 1913. President, W. D. Hunter; First Vice-President, T. J. Headlee; Second Vice-President, R. A. Cooley; Secretary, A. F. Burgess.

Twenty-sixth Annual Meeting, Atlanta, Ga., Dec. 31, 1913–Jan. 2, 1914. President, P. J. Parrott; First Vice-President, E. L. Worsham; Second Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Twenty-seventh Annual Meeting, Philadelphia, Pa., Dec. 28–31, 1914. President, H. T. Fernald; First Vice-President, Glenn W. Herrick; Second Vice-President, W. E. Britton; Third Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Special Meeting, Berkeley, Cal., Aug. 9–10, 1915. (Officers same as for Twenty-eighth Annual Meeting.)

Twenty-eighth Annual Meeting, Columbus, Ohio, Dec. 27–30, 1915. President, Glenn W. Herrick; First Vice-President, R. A. Cooley; Second Vice-President, W. E. Rumsey; Third Vice-President, E. F. Phillips; Secretary, A. F. Burgess.

Twenty-ninth Annual Meeting, New York, N. Y., Dec. 28–30, 1916. President, C. Gordon Hewitt; First Vice-President, G. A. Dean; Second Vice-President, E. D. Ball; Third Vice-President, W. J. Schoene; Fourth Vice-President, T. J. Headlee; Secretary, A. F. Burgess.

Thirtieth Annual Meeting, Pittsburgh, Pa., Dec. 31, 1917–Jan. 2, 1918. President, R. A. Cooley; First Vice-President, W. E. Hinds; Second Vice-President, A. W. Morrill; Third Vice-President, G. M. Bentley; Fourth Vice-President, B. N. Gates; Secretary, A. F. Burgess.

Thirty-first Annual Meeting, Baltimore, Md., Dec. 26–27, 1918. President, E. D. Ball; First Vice-President, W. C. O'Kane; Second Vice-President, G. P. Weldon; Third Vice-President, E. C. Cotton; Fourth Vice-President, Franklin Sherman, Jr.; Secretary, A. F. Burgess.

Thirty-second Annual Meeting, St. Louis, Mo., Dec. 31, 1919–Jan. 2, 1920. President, W. C. O'Kane; First Vice-President, A. G. Ruggles; Second Vice-President, H. J. Quayle; Third Vice-President, E. C. Cotton; Fourth Vice-President, W. E. Britton; Secretary, A. F. Burgess.

Thirty-third Annual Meeting, Chicago, Ill., Dec. 29–31, 1920. President, Wilmon Newell; First Vice-President, H. A. Gossard; Second Vice-President, E. M. Ehrhorn; Third Vice-President, J. G. Sanders; Fourth Vice-President, F. B. Paddock, Secretary, A. F. Burgess.

Thirty-fourth Annual Meeting, Toronto, Canada, Dec. 29–31, 1921. President, George A. Dean; First Vice-President, Arthur Gibson; Second Vice-President, E. O. Essig; Third Vice-President, A. G. Ruggles; Fourth Vice-President, H. F. Wilson; Secretary, A. F. Burgess.

Thirty-fifth Annual Meeting, Boston, Mass., Dec. 28–30, 1922. President, J. G. Sanders; First Vice-President, J. M. Swaine; Second Vice-President, A. L. Lovett; Third Vice-President, R. W. Harned; Fourth Vice-President, M. C. Tanquary; Secretary, A. F. Burgess.

Thirty-sixth Annual Meeting, Cincinnati, Ohio, Dec. 29, 1923–Jan. 2, 1924. President, A. G. Ruggles; First Vice-President, H. A. Gossard; Second Vice-President, H. J. Quayle; Third Vice-President, P. A. Glenn; Fourth Vice-President, S. B. Fracker; Secretary, A. F. Burgess.

Thirty-seventh Annual Meeting, Washington, D. C., December 31, 1924–January 3, 1925. President, A. F. Burgess; First Vice-President, M. C. Tanquary; Second

Vice-President, H. S. Smith; Third Vice-President, E. R. Sasscer; Fourth Vice-President, R. W. Harned; Secretary, C. W. Collins.

Thirty-eighth Annual Meeting, Kansas City, Mo., December 29, 1925-January 1, 1926. President, H. A. Gossard (died in office December 18, 1925); First Vice-President, R. N. Chapman (assumed duties of President for remainder of term); Second Vice-President, Leroy Childs; Third Vice-President, C. H. Hadley; Fourth Vice-President, R. L. Webster; Secretary, C. W. Collins.

Thirty-ninth Annual Meeting, Philadelphia, Pa., December 28, 1926-January 1, 1927. President, Arthur Gibson; First Vice-President, C. J. Drake; Second Vice-President, W. B. Herms; Third Vice-President, L. A. Strong; Fourth Vice-President, J. I. Hambleton; Fifth Vice-President, W. E. Hinds; Secretary, C. W. Collins.

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Grand Total of Members, 934.

Fortieth Annual Meeting

of the

American Association of Economic Entomologists

Nashville, Tenn.

December 27 to 31, 1927

Fortieth Annual Meeting of the American Association of Economic Entomologists, Nashville, Tenn.

December 27 to 31, 1927

The 40th annual meeting of the American Association of Economic Entomologists will be held at Nashville, Tenn., on the above-named dates. The meeting of the Section of Plant Quarantine and Inspection will be held Tuesday, December 27. The Section of Apiculture will open its meeting at 3 P. M. Tuesday and continue through that day and conclude with a session Wednesday morning.

The opening business session of the general Association and address of the President will be held Wednesday afternoon. The entomologists' dinner has been arranged for Wednesday at 7 P. M. On Thursday morning, December 29, there will be readings of papers before the general Association; in the afternoon a joint session will be held with the Cotton States Branch; at 8 P. M., there will be a meeting of the extension entomologists and Insect Pest Survey. Friday will be devoted to reading of papers before the general Association. The reading of papers will continue Saturday morning and the session will conclude with final business. If there proves to be ample time for presentation of papers and the transaction of final business by the close of the Friday afternoon session, it may not be necessary to continue into Saturday. This Association and its sections will meet in North Gymnasium, Southern Y. M. C. College, on Hillsboro Road, opposite Vanderbilt University.

Sectional Meetings

The meeting of the Section of Plant Quarantine and Inspection will be held at 9:30 A. M., Tuesday, and will continue until 3 P. M. The Section of Apiculture will meet at 3 P. M. and conclude with a session Wednesday morning.

Other Meetings

The annual meeting of the American Association for the Advancement of Science, its sections and associated societies, will be held December 26 to 31, 1927.

The Entomological Society of America will open its meeting on Tuesday morning, December 27, and will continue through Wednesday, December 28. The annual public address before that society will be delivered by Prof. H. T. Fernald, Amherst, Mass., on Tuesday evening at 8 o'clock. Members of this Association are especially invited to attend this session.

The extension entomologists and Insect Pest Survey will hold a meeting on Thursday, December 29, at 8 P. M. Details of this meeting will be announced at the day session. The Crop Protection Institute will probably have an evening meeting, the details of which will be announced later.

Hotel Headquarters

The Hermitage Hotel, Union and Sixth Streets, will be headquarters for this Association and the Entomological Society of America. Rates as follows:

Single rooms	$2.00 to $4.00
Double rooms	4.00 to 6.00

All rooms with bath.

Railroad Rates

Practically all railroads offer reduced fares to the meeting of the A. A. A. S. Members should secure a certificate when purchasing tickets, stating that they are attending the meeting of the American Association for the Advancement of Science; leave the certificate at the registration room for endorsement and validation, and present the certificate when purchasing return ticket to secure one-half regular fare for the return trip. A charge of $1.00 will be made for validation.

Dinner

The entomologists' dinner will be held at the Hermitage Hotel on Wednesday evening, December 28, at 7 o'clock. All entomologists are cordially invited to attend.

Membership

Applications for membership can be secured from the Secretary or from the Committee on Membership. These should be filled out, properly endorsed, and filed with the Membership Committee on or before December 28. Each application must be accompanied with fee of $4.00 to cover dues and subscription to the JOURNAL for the year following election.

Exhibits

Members are requested to make exhibits of appliances, apparatus, photographs, maps or models demonstrating life history or control methods in preventing insect damage. Such exhibits will be displayed near the meeting room. Those wishing to send exhibits should do so in advance and should correspond directly with G. M. Bentley, State Entomologist, Knoxville, Tenn., who is in charge of local arrangements for the Association.

A. A. A. S.—Membership

Special privilege is granted this year to all our members to join the American Association without payment of the usual entrance fee. Application cards available through the Secretary of that organization.

Program

SECTION OF PLANT QUARANTINE AND INSPECTION

J. H. MONTGOMERY, *Chairman* W. B. WOOD, *Secretary*

Tuesday Morning Session, December 27, 9:30, North Gymnasium, Y. M. C. College

Address by the Chairman, J. H. Montgomery, Gainesville, Florida.

1. The National Plant Quarantine Board. Wilmon Newell, Gainesville, Fla.

2. REPORTS OF REGIONAL BOARDS:

   The Plant Conference Board of the Middle Atlantic and Northeastern States. T. J. Headlee, New Brunswick, N. J.

   The Central States Advisory Plant Board. L. Haseman, Columbia, Mo.

   The Southern Plant Quarantine Board. R. W. Harned, A. & M. College, Miss.

   The Western Plant Quarantine Board.

Program

Tuesday Afternoon Session, December 27, 1:30

READING OF PAPERS AND DISCUSSIONS

3. ACTIVITIES OF THE FEDERAL HORTICULTURAL BOARD:

   Recent Developments in Federal Plant Quarantine. C. L. Marlatt, Washington, D. C.

   Progress in Preventing the Spread of the Cornborer. H. N. Worthley.

   The Present Status of the Pink Bollworm and the Thurberia Weevil. G. G. Becker, Little Rock, Ark.

   The results of Control Measures in Preventing the Spread of Three Imported Insects: the Japanese Beetle, the Asiatic Beetle and the Green Garden Beetle. L. B. Smith, Moorestown, N. J.

   Narcissus Inspection Problems. S. B. Fracker, Washington, D. C.

Developments in the White Pine Blister Rust Situation. S. B. Detwiler.

Progress of the Mexican Fruit Worm Eradication. A. C. Baker, Washington, D. C.

4. The Mediterranean Fruit Fly—Observations of a Fruit Grower. A. C. Hardison.

5. Pacific Port Inspection. L. A. Strong, Sacramento, Calif.

6. Progress in the Eradication of Citrus Canker and Remarks on the Present Status of the Potato Wart Disease. Karl F. Kellerman.

7. Shall the Station Entomologist Also Direct the State Regulatory Work? L. Haseman, Columbia, Mo.

8. Pear Blight Eradication in Northwest Arkansas. G. G. Becker, San Antonio, Texas.

9. General Discussion—Round Table.

Reports of Committees.

Selection of Officers.

Adjournment.

Program

SECTION OF APICULTURE

F. E. Millen, *Chairman* G. M. Bentley, *Secretary*

Tuesday Afternoon Session, December 27, 3:00, North Gymnasium, Y. M. C. College

Address by the Chairman, F. E. Millen, Guelph, Canada.

READING OF PAPERS AND DISCUSSIONS

1. The Cause of Fermentation or Souring of Honey. (15 min.) (Lantern.) George E. Marvin, Madison, Wisc.

2. Some Points in Handling Honeybee Packages, Both in Shipping and Installing them. (15 min.) Morley Pettit, Guelph, Canada.

3. The Amoeba Disease of the Honeybee in the United States. (10 min.) J. W. Bulger, Bureau of Entomology, Washington, D. C.

4. Area Cleanup of Foulbrood. (15 min.) F. E. Millen, Guelph; Canada.

5. New Diseases of Honeybees. (10 min.) C. E. Burnside, Washington, D. C.

Program

Wednesday Morning Session, December 28, 9:30

SECTION OF APICULTURE—*Continued*

READING OF PAPERS AND DISCUSSIONS

6. Disinfecting Combs. (15 min.) G. L. Jarvis, Guelph, Canada.
7. Colony Population. (10 min.) W. J. Nolan, Washington, D.C.
8. Crop Failure. (10 min.) J. M. Robinson, Auburn, Ala.
9. Marketing Honey. (15 min.) George E. Demuth, Medina, Ohio.
10. The Pathogenic Effect of the Mite, *Acarapis woodi* Hirst, on the Thoracic Tissues of the Honeybee. (5 min.) (Lantern.) E. J. Anderson, State College, Pa.

SYMPOSIUM—PROGRESS REPORTS IN APICULTURAL RESEARCH

Led by J. I. Hambleton, Washington, D. C.

Reports of Committees.

Selection of Officers.

Adjournment.

Program

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Wednesday Afternoon Session, December 28, 1:30, North Gymnasium, Y. M. C. College

Report of the Secretary.

Report of the Executive Committee, by President R. W. Harned.

Report of the Representative to the National Research Council, by W. A. Riley, St. Paul, Minn.

Report of the Committee on Policy, by Arthur Gibson, Ottawa, Canada.

Report of the Trustees of the Crop Protection Institute, by W. C. O'Kane, Durham, N. H.

Report of Scientific Trustee, Tropical Plant Research Foundation, by Herbert Osborn, Columbus, Ohio.

Report of the Representatives on the Council of the Union of American Biological Societies, by A. L. Quaintance, Washington, D. C.

Report of the Committee on Nomenclature, by E. O. Essig, Berkeley, Calif.

Report of Committee on Endowment, by A. F. Burgess, Melrose Highlands, Mass.

Report of Editorial Board on Index to Economic Entomology, by E. P. Felt, Albany, N. Y.

Report of Board of Trustees for Permanent Fund, by C. W. Collins, Melrose Highlands, Mass.

Report of the Committee on United States National Museum, by W. E. Hinds, Baton Rouge, La.

Report of Program Committee, by W. E. Britton, New Haven, Conn.

Report of Committee to Formulate Plans for Investigation of the Codling Moth from Biologic and Control Standpoints. by A. L. Quaintance. Washington, D. C.

Report of Advisory Committee, Entomologists and Agronomists on Research and Control of European Corn Borer, by George A. Dean, Manhattan, Kansas.

Report of Committee on Insect Pest Survey, by C. R. Crosby, Ithaca, N. Y.

Report of Representative to International Zoological Congress at Budapest, Hungary, by L. O. Howard, Washington, D. C.

Report of the Committee on Amendment to the Constitution by P. A. Glenn, Urbana, Ill.

Report of Committee for Holding 4th International Entomological Congress in America, by L. O. Howard, Washington, D. C.

Remarks—4th International Entomological Congress, by G. W. Herrick, Ithaca, N. Y.

Appointment of Committees.

Miscellaneous Business.

New Business.

Annual Address of the President, R. W. Harned, A. & M. College, Miss.

1. Entomology in the Southern States

Discussion of the Presidential Address.

READING OF PAPERS

Insects Affecting Cereal, Forage and Field Crops

(European Corn Borer)

2. The Status of the European Corn Borer in Canada (1927). (5 min.) L. S. McLaine and H. G. Crawford, Entomological Branch, Ottawa, Canada.

A brief report on the extent of spread and the increase in intensity of infestation in certain sections.

3. Corn Borer Research and the Ten Million Dollar Clean-up Campaign. (5 min.) (Lantern.) D. J. Caffrey, Corn Borer Laboratory, Arlington, Mass.

4. Corn Borer Control and the Ten Million Dollar Clean-up Campaign. (5 min.) L. H. Worthley, 615 Front Street, Toledo, Ohio.

5. Results of the Ten Million Dollar Corn Borer Clean-up Campaign. (5 min.) W. H. Larrimer, Bureau of Entomology, Washington, D. C.

6. The Correlation of European Corn Borer Accumulation with Soil Fertility. (5 min.) (Lantern.) L. L. Huber and C. R. Neiswander, Ohio Experiment Station, Wooster, Ohio.

In a former paper (1926) it was pointed out that certain vegetative types may be used as indices of corn borer accumulations. This paper will show that soil fertility may likewise be correlated with the rapid accumulation of the insect.

7. Fundamental Phases of European Corn Borer Research. (5 min.) L. L. Huber, Wooster, Ohio and D. J. Caffrey, Arlington, Mass.

A general discussion of results and plans for development in corn borer investigations pertaining to parasites, insecticides, mechanical measures and cultural practices.

Program

Thursday Morning Session, December 29, 9:30

SYMPOSIUM ON INSECTICIDES

8. Recent Developments in Proprietary Insecticides. (10 min.) W. S. Abbott, Bureau of Entomology, Vienna, Va.

9. Soil Insecticides. (10 min.) W. E. Fleming, Japanese Beetle Laboratory, Moorestown, N. J.

10. The Relative Toxicities of Arsenicals and Fluorine Compounds to Various Organisms. (10 min.) (Lantern.) S. Marcovitch, Agricultural Experiment Station, Knoxville, Tenn.

11. Comments on the Determination of the Relative Toxicity of Insecticides. (10 min.) C. H. Richardson, Bureau of Entomology, Washington, D. C.

READING OF PAPERS

INSECTICIDES AND APPLIANCES

12. Testing New Insecticides. (5 min.) L. Haseman, Columbia, Mo.

A brief discussion of the ever increasing flood of new insecticides and the importance of entomologists co-operating with the Federal Insecticide and Fungicide Board in eliminating the worthless brands from the market.

13. Fish Oil as an Adhesive in Control of Codling and Grape berry Moths. (5 min.) H. L. Dozier, Agricultural Experiment Station, Newark, Del.

A brief report of preliminary work, showing its possibilities, in orchard and vineyard.

14. Analyses of Sprayed Apples for Lead and Arsenic. (5 min.) (Lantern.) Albert Hartzell and Frank Wilcoxon, Boyce Thompson Institute for Plant Research, Yonkers, N. Y.

In continuation of work reported in 1926, analytical data are presented for lead and arsenic on apples sprayed according to a standard schedule during the season of 1927.

15. The Results of Three Years Work with the Dust Sprays in Missouri. (5 min.) K. C. Sullivan, Columbia, Mo.

The general results indicate that the dusts should be used only as a supplement to the liquid sprays.

16. Physiological Studies on the Effect of Fluorides and Fluosilicates on the Respiratory Metabolism of Insects. (5 min.) (Lantern.) David E. Fink, University of Pennsylvania, Philadelphia, Pa.

17. Toxicity of Lead to Insects. (5 min.) F. J. Brinley, University of Pennsylvania, Philadelphia, Pa.

Certain lead salts are definitely toxic to tent caterpillars. The amount of lead in the body of the insect, exclusive of the alimentary canal, remains constant regardless of the quantity of lead consumed.

18. Recent Developments in Pear Psylla Control. (5 min.) H. J. Grady, 209 Clark Street, Augusta, Kansas.

The use of summer oil (Volck) in the summer control of psylla and the results obtained the past two seasons.

19. A Bibliography of Ethylene Dichloride (Read by title.) W. A. Gersdorff and R. C. Roark, Bureau of Chemistry and Soils, Washington, D. C.

20. The Composition of Fluorides and Fluosilicates Sold as Insecticides. (Read by title.) R. H. Carter and R. C. Roark, Washington, D. C.

21. Fumigation Tests with Certain Chlorinated Hydrocarbons. (5 min.) R. C. Roark, Bureau of Chemistry and R. T. Cotton, Bureau of Entomology, Washington, D. C.

Tests with aliphatic chlorides as fumigants are reported upon. Many of these chlorides are commercially available, cheap, not readily inflammable, non-injurious to man, and are toxic to insects.

INSECTS AFFECTING THE HOUSEHOLD AND STORED PRODUCTS

22. House and Flour Mill Fumigation with Calcyanide. (5 min.) Roger C. Smith, Agricultural College, Manhattan, Kansas.

A summary of a series of tests with this material with a discussion of the factors involved in this type of fumigation.

23. Preventing Insect Damage to Stored Grains. (5 min.) (Lantern.) W. P. Flint, State Entomologist Building, Urbana, Ill.

A number of chemicals were mixed with the grain and it was then exposed to infestation. Several of these materials, notably mixtures of hydrated lime and creosote, copper carbonate, and calcium fluosilicate gave very good protection.

24. Control of Insects in Stored Seeds with Organic Mercury Compounds. (5 min.) J. L. Horsfall, 1086 N. Broadway, Yonkers, N. Y.

Preliminary report showing that beans, corn and wheat treated with nitrophenol mercury and chlorophenol mercury in dust form furnishes a control of certain insects while the seeds are in storage.

25. The Toxicity of Fumigants as Affected by the Presence of Grain. (5 min.) A. L. Strand, University of Minnesota, St. Paul, Minn.

26. Cyanogas Calcium Cyanide for the Fumigation of Flour Mills. (5 min.) S. W. Bromley, 535 Fifth Avenue, New York, N. Y.

The application of Cyanogas Calcium Cyanide has proven a simple, effective and comparatively safe method of utilizing HCN in the fumigation of flour mills. The development of the method is described in the present paper.

27. Experiments with Vacuum-Disulphid Fumigation of Dried Figs Under Commercial Conditions. (5 min.) J. C. Hamlin and W. D. Reed, Box 2696, Tampa, Fla.

Presents experimental data on this method of vacuum fumigation in relation to effectiveness against revival and survival of treated insects at various seasons of the year.

28. Macroscopical Examination of Fumigated Plodia Larvae in Relation to Their Revival Potentialities. (5 min.) J. C. Hamlin and W. D. Reed, Box 2696, Tampa, Fla.

Observations on the external characteristics of larvae reviving after fumigation with carbon disulphid.

29. Moth-proofing Solutions. (5 min.) (Lantern.) E. A. Back and R. T. Cotton, Bureau of Entomology, Washington, D. C.

Statement regarding the composition, use and effectiveness of these solutions.

Program

Thursday Afternoon Session, December 29, 1:30

JOINT SESSION, MAIN ASSOCIATION WITH COTTON STATES BRANCH

Reading of Papers

30. Summary of Boll Weevil Damage to Cotton in the South in 1927. (5 min.) R. W. Leiby, Raleigh, N. C.

Compilation of damage by various entomologists in the cotton states.

31. Four Years of Boll Weevil Control under Uniform Soil Conditions in Alabama. (5 min.) (Lantern.) J. M. Robinson, Auburn, Ala.

32. Oviposition Rate of the Boll Weevil in Relationship to Food. (5 min.) (Lantern.) Dwight Isely, University of Arkansas, Fayetteville, Ark.

Relation of squares and bolls as food of adult weevils to the rate of oviposition.

33. The Preparation of a Special Light Sodium Fluosilicate and its Use as a Boll Weevil Poison. (Lantern.) H. W. Walker, Chemical Warfare Service, Edgewood, Md.

34. The Preparation of Special Calcium Arsenates Containing Less Than 40% Arsenic as As_2O_5 and Their Use as Boll Weevil Poisons. (Lantern.) H. W. Walker, Edgewood, Md.

35. Calcium Arsenate as a Cause of Aphis Infestation. (5 min.) J. W. Folsom, Bureau of Entomology, Tallulah, La.

36. Biological Control of the Green Citrus Aphid (*Aphis spiraecola* Patch) in Florida. (5 min.) (Lantern.) R. L. Miller, Ohio State Univ., Columbus, O.

This paper comprises a summary of work done and observations made on the abundance, seasonal appearance and economic importance of all natural enemies of the green citrus aphid.

37. A Preliminary Report on the Toxic Value of Fluosilicates and Arsenicals as tested on the Plum Curculio. (5 min.) (Lantern.) Oliver I. Snapp, Bureau of Entomology, Fort Valley, Ga.

The results of fifty feeding tests in which sodium and calcium fluosilicates and eight arsenicals are used.

INSECTS AFFECTING TRUCK CROPS

38. The Present Status of the Mexican Bean Beetle. (5 min.) (Lantern.) N. F. Howard, Bureau of Entomology, Columbus, Ohio.

A brief statement of the spread and damage by this insect during 1927 and suggestions as to future investigations.

39. The Economic Importance of the Bean Leaf Hopper in North Carolina. (5 min.) (Lantern.) Z. P. Metcalf, State College Station, Raleigh, N. C.

A brief discussion of the damage caused by this insect to beans, soy beans, peanuts and cotton in North Carolina.

40. Some Further Observations upon the Biology and Control of *Empoasca fabae*. (5 min.) (Lantern.) D. M. DeLong, Ohio State University, Columbus, O.

Seasonal occurrence, preferred host plants, life history observations, seasonal generation and comparative control results.

41. Investigations of the Potato Tuberworm, *Phthorimaeae operculella* Zell., in Virginia during 1926 and 1927. (5 min.) F. W. Poos and H. S. Peters, Virginia Truck Experiment Station, Norfolk, Va.

History and importance in Virginia. Further studies on biology and control.

42. Some Chemotropic Responses of the Tobacco Hornworm Moth. (5 min.) (Lantern.) A. C. Morgan and S. C. Lyon, Box 346, Clarksville, Tenn.

Amyl Salicylate incites a decided feeding response in Tobacco Hornworm moths. Amyl Benzoate is also very attractive. Large numbers of Tobacco Moths and other Sphingidae were caught in traps baited with Amyl Salicylate.

43. Tarnished Plant Bug Injury to Strawberries. (5 min.) (Lantern.) L. Haseman, University of Missouri, Columbia, Mo.

Brief discussion of a very severe attack of tarnished plant bug resulting in practically a hundred per cent loss over a considerable acreage of strawberries in Southwest Missouri.

INSECTS AFFECTING MAN AND ANIMALS

44. The Toxicity to Flies of Certain Materials Used as Fly Sprays. (5 min.) H. M. Brundrett, F. C. Bishopp and E. W. Laake, Bureau Entomology, Washington, D. C.

A preliminary statement on the results of experiments to determine an effective toxic spray for use against flies, including a brief discussion of the equipment, and methods employed in the studies.

Program

Friday Morning Session, December 30, 9:30

READING OF PAPERS

Insects Affecting Cereal, Forage and Field Crops

45. The Hibernation of Chinch Bugs (*Blissus leucopterus* Say) in Sudan Grass. (Read by title.) H. R. Bryson, Agricultural College, Manhattan, Kansas.

A study relating to the efficiency of Sudan grass stubble and uncut bunches as over-wintering quarters for the chinch bug.

46. Ecological Studies of Scarabaeid Larvae. (5 min.) (Lantern.) J. W. McColloch and W. P. Hayes, Manhattan, Kansas and Urbana, Ill.

A study of the mortality, food habits, habitat preference and abundance of larvae made during eight years observation.

47. A Power-Driven Grasshopper Catcher. (5 min.) (Lantern.) W. C. O'Kane, State Entomologist, Durham, N. H.

48. The Influence of Temperature on the Feeding of Grasshoppers. (5 min.) G. S. Langford, Fort Collins, Colo.

A new method for studying the food habits of grasshoppers, the results obtained and their relation to temperature.

49. Alfalfa Yellow Top and Leafhoppers. (5 min.) (Lantern.) A. A. Granovsky, University of Wisconsin, Madison, Wisc.

50. Hibernation of the Grape Colaspis, *Colaspis brunnea* Fab. (4 min.) J. H. Bigger, 1114 S. Main Street, Jacksonville, Ill.

Information on hibernation habits of this insect. Notes made in connection with life history studies of this insect on red clover and corn.

51. Insecticidal Control for the Sugarcane Borer. (5 min.) W. E. Hinds and Herbert Spencer, Louisiana Experiment Station, Baton Rouge, La.

Presenting the most significant results from three seasons of field work in the control of *Diatraea saccharalis* by dust applications of Sodium silicofluoride.

52. Utilization of *Trichogramma minutum* in Sugarcane Borer Control. (5 min.) (Lantern.) Herbert Spencer and W. E. Hinds, Baton Rouge, La.

Presenting results of field examinations in borer control occurring naturally during two seasons and describing methods and plans for increasing the effectiveness of this most important native parasite of the cane borer.

53. Some Temperature Relations of Melanotus (Coleoptera). (3 min.) B. B. Fulton, Iowa State College, Ames, Iowa.

Experiments on temperature tolerance of wireworm larvae and adults in relation to distribution and habits.

54. *Barathra configurata* Wlk., an Armyworm of Important Potentialities in the Prairies. (5 min.) K. M. King, Entomological Laboratory, Saskatoon, Can.

This paper deals chiefly with the life history, economic importance and means of distinguishing the immature stages from several other species of similar habits or appearance.

55. Wireworms and False Wireworms of Economic Importance in Saskatchewan. (5 min.) K. M. King, Entomological Laboratory, Saskatoon, Can.

Discusses the present and potential economic status of wireworms in Saskatchewan, with estimates of crop losses caused by them in 1926, and detailed examples of injured fields.

Insects Affecting Forest and Shade Trees and Ornamental Plants

56. Hot Water Immersion for the Control of the Box Leaf Miner, *Monarthropalpus buxi*. (5 min.) (Lantern.) F. F. Smith, H. J. Fisher and T. L. Guyton, Department of Agriculture, Harrisburg, Pa.

The development of a new treatment for this serious pest of box wood in which a water bath is used at the temperature of 120 degrees F., with seven minutes duration, or 122 with five minutes duration gave satisfactory control.

57. Injection Experiments for Controlling Insects. (5 min.) W. O. Hollister, Davey Tree Expert Co., Kent, Ohio.

Discussion of methods of injection, materials used, effect on trees and insects.

58. Present Status of the Gipsy Moth Problem. (5 min.) (Lantern.) A. F. Burgess, Melrose Highlands, Mass.

59. Small Mammals and the Larch Sawfly. (5 min.) S. A. Graham, Univ. of Michigan, Ann Arbor, Mich.

This paper summarizes the results to date of a series of quantitative experiments of the effect of various factors, particularly the effect of mice and shrews upon the abundance of the larch sawfly.

Insects Affecting Deciduous Fruits

(Japanese Beetle)

60. Some Phases of the Japanese Beetle Insecticide Investigations. (5 min.) E. R. Van Leeuwen, Box H, Moorestown, N. J.

This paper is limited to a discussion of some of the problems and difficulties experienced, as well as the progress made in the insecticide work against the adult Japanese beetle.

61. A Trap for the Japanese Beetle (*Popillia japonica* Newm.). (5 min.) (Lantern.) E. Avery Richmond and F. W. Metzger, Box H. Moorestown, N. J.

Four years' experiences relative to the evolution of a trap for the Japanese beetle.

62. Hot Water as an Insecticide for the Japanese Beetle in the Roots of Nursery Stock. (5 min.) W. E. Fleming, Riverton, N. J.

63. Progress with the Imported Parasites of the Japanese Beetle during 1927. (5 min.) (Lantern.) H. W. Allen and H. A. Jaynes, Box H, Moorestown, N. J.

A summary of the work with introduced parasites and the results obtained at the Japanese Beetle Laboratory, Riverton, N. J., since January 1, 1927.

Program

Friday Afternoon Session, December 30, 1:30

READING OF PAPERS

INSECTS AFFECTING DECIDUOUS FRUITS—*Continued*

64. The European Red Mite. (5 min.) (Lantern.) J. S. Houser, Wooster, O.

Record of control experiments and interpretation of results.

65. Observations on European Red Mite. (5 min.) J. G. Sanders, Sun Oil Company, Philadelphia, Pa.

66. The Codling Moth as an Established Pest of Stone Fruits. (5 min.) Ralph H. Smith, Citrus Experiment Station, Riverside, Calif.

Recent investigations indicate that the codling moth has become established on plums and peaches in parts of California.

67. Codling Moth Hibernation Studies. (5 min.) (Lantern.) S. C. Chandler, Route 5, Carbondale, Ill.

These studies indicate relative numbers of hibernating larvae on different parts of the trunks of apple trees and in various types of cover between the trees. Results are given of applications of contact sprays against hibernating larvae.

68. An Investigation of Spray Coverages and Arsenical Residue in Relation to Codling Moth Control. (5 min.) R. H. Smith, Riverside, Calif.

69. Codling Moth Control in Georgia Apple Orchards. (5 min.) C. H. Alden and M. S. Yeomans, Cornelia, Ga.

Life history, dusting and spraying, and banding experiments conducted in the apple orchards of North Georgia during the 1927 season for the control of the codling moth.

70. Second Report on Chemically Treated Bands for Destruction of Codling Moth Larvae. (5 min.) E. H. Siegler, Luther Brown, A. J. Ackerman and E. R. Van Leeuwen, Bureau of Entomology, Silver Spring, Md.

Results of tests with chemically treated bands indicate the possibility that such bands may be employed in place of the old type band. Hand labor is required to destroy the codling moth larvae that spin beneath the old type band. The chemically treated bands are self-acting.

71. Tropic Responses of Codling-moth Larvae. (5 min.) N. E. McIndoo, Bureau of Entomology, Washington, D. C.

Throws light on biology of codling moth and explains why larvae go under bands.

72. Is the Codling Moth Attracted by Light? (5 min.) M. A. Yothers, Box 243, Yakima, Wash.

It has long been supposed that the codling moth was not attracted by lights. Recent tests show this is not true. Brief resume of experiments in 1926 and 1927 are presented.

73. Relative Resistance to Arsenical Poisoning of two Codling Moth Strains. (5 min.) (Lantern.) W. S. Hough, Winchester, Va.

A summary of one year's investigation of the comparative resistance to lead arsenate poisoning of Colorado and Virginia codling moth larvae.

74. An Operation in Practical Control of Codling Moth in a Heavily Infested District—Second Report. (5 min.) T. J. Headlee, New Brunswick, N. J.

This paper is a continuation of the work carried on in 1926 and reported in the last annual meeting. The work of 1927 shows a further advance in clean fruit.

75. Report on Orchard Tests Conducted during 1927 for the Control of Codling Moth in the Yakima Valley, Washington. (5 min.) W. S. Regan and A. B. Davenport, Box 853, Yakima, Wash.

Tests continued on several varieties of apples and pears with combination arsenate of lead and oil and oil alone. Five different oils tested.

76. Continued Studies with Baits for the Oriental Fruit Moth. (5 min.) S. W. Frost, Arendtsville, Pa.

This paper includes (1) comparative tests with various baits; (2) factors affecting the catches of moths, and (3) value of bait pails as a means of control.

77. Preliminary Tests with Possible Repellents for the Oriental Peach Moth. (Read by title.) Joseph W. Lipp, 228 E. Upsal St., Mt. Airy, Phila., Pa.

Methods and materials used are discussed in this paper.

78. The Determination of the Spring Brood of Oriental Peach Moths and Codling Moths Using Various Methods. (5 min.) (Lantern.) Alvah Peterson and G. J. Haeussler, Japanese Beetle Laboratory, Moorestown, N. J.

Overwintering cocoons of both species were placed in various types of cages and containers and located in orchards and in a packing shed. Striking difference in the time of emergence of the adults took place in varying locations and containers.

79. Factors which Enter into the Control of the Pecan Nut Casebearer. (5 min.) G. F. Moznette, P. O. Box 482, Albany, Ga.

A study of the feeding habits of *Acrobasis caryae* Grote and their bearing on control with lead arsenate.

80. A New Insect Pest of Pecans—in Alabama. Tetralopha sp. (5 min.) J. M. Robinson, Auburn, Ala.

MISCELLANEOUS

81. Water Conservation in Insects. (5 min.) William Robinson, University of Minnesota, St. Paul, Minn.

Insects which live on food low in water have the capacity, like the cactus, of holding much of their water in the bound or colloidal condition. This capacity varies directly as the total water content of the insect.

82. Precipitation as a Measure of the Moisture Factor in the Ecology on Insects in Irrigated Regions. (5 min.) (Lantern.) H. L. Sweetman, Laramie, Wyo.

Precipitation studies in the Western States do not give a true impression of the moisture environment to which insects are exposed in irrigated fields.

83. The Bionomics of *Polynema striaticorne* Girault (Mymaridae, Hymenoptera), a Parasite in the Egg of the Buffalo Tree Hopper, *Ceresa bubalus* Fab., (Membracidae, Homoptera). (5 min.) (Lantern.) W. V. Balduf, University Illinois, Urbana, Ill.

1. Observations on the host. 2. The habits of the parasite, and its development. 3. The economic importance of the parasite.

84. Quantitative Results in the Prediction of Insect Abundance on the Basis of Biotic Potential and Environmental Resistance. (5 min.) R. N. Chapman, University Farm, St. Paul, Minn.

85. European Entomology and Entomologists. (5 min.) R. N. Chapman, University Farm, St. Paul, Minn.

Program

Saturday Morning Session, December 31, 9:30

READING OF PAPERS

INSECTS AFFECTING BULBS AND GREENHOUSE CROPS AND TROPICAL AND SUBTROPICAL PLANTS

86. Mushroom Insects: Observations on their Life-histories, Habits and Control. (5 min.) C. A. Thomas, Pa. State College Laboratory, Bustleton, Pa.

Observations on the biology of Sciarid and Phorid Flies, Springtails and Tyroglyphid Mites affecting cultivated mushrooms, together with the results of some control experiments.

87. Results of Forcing Hot Water Treated Narcissus Bulbs. (5 min.) (Lantern.) C. A. Weigel, Bureau of Entomology, Washington, D. C.

Discusses flowering results obtained with bulbs which have been given the hot water treatment which is used for the control of the narcissus fly, *Merodon equestris*, and the lesser bulb fly, *Eumerus* spp.

88. Developmental History of the Narcissus Bulb Fly at Washington, D. C. (5 min.) (Miss) B. M. Broadbent, 2224 Gentilly Road, New Orleans, La.

Brief review of development of *Merodon equestris*, including notes on duration of larval period, and total time from egg deposition to emergence of fly.

89. Observations on the Habits and Control of the Garden Centipede, *Scutigerella immaculata* Newport, a Pest in Greenhouses. (5 min.) (Lantern.) G. A. Filinger, Ohio Experiment Station, Wooster, Ohio.

A discussion of the habits of the garden centipede as observed in greenhouses and some of the results obtained with several control measures.

90. Estimating the Toxicity of Oil Emulsions to Camphor Scale. (5 min.) (Lantern.) C. I. Bliss and A. W. Cressman, 2224 Gentilly Road, New Orleans, La.

Environmental factors influencing normal mortality in overwintering camphor scale. Their effect on spray counts. Relation of oil concentration and density of scale population to survival.

FINAL BUSINESS

Report of Committee on Resolutions.
Report of Committee on Membership.
Reports of other committees.
Nomination of JOURNAL officers by advisory committee.
Report of Committee on Nominations.
Election of Officers.
Miscellaneous business.
Fixing the time and place of next meeting.
Final adjournment.

R. W. HARNED, *President*,
A. & M. College, Miss.

C. W. COLLINS, *Secretary*,
Melrose Highlands, Mass.

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Proceedings of the Thirty-Ninth Annual Meeting of the American Association of Economic Entomologists

The thirty-ninth annual meeting of the American Association of Economic Entomologists was held in Logan Hall, University of Pennsylvania, Philadelphia, Pa., December 28, 1926 to January 1, 1927.

The Section of Plant Quarantine and Inspection convened at 10 a. m., Dec. 28 and continued through that day. In the absence of Chairman L. A. Strong, C. H. Hadley of Harrisburg, Pa. was elected Chairman pro tem. Dr. C. L. Marlatt, Chairman of the Federal Horticultural Board, spoke on the "Effect of the Supreme Court Decision of March 1, 1926, in the Case of the Oregon-Washington Railroad and Navigation Company vs. the State of Washington on the Basic Quarantine Laws of the Various States." The above subject was opened by Dr. Marlatt and continued as a round-table discussion by the various members. Several other very interesting papers were presented, among these being two papers on "Inspection of Vehicular Traffic in the Enforcement of Plant Quarantines" with reference to the Japanese Beetle and the European Corn Borer.

The Section of Apiculture held an interesting session Wednesday afternoon, December 29, and was continued in the evening; 11 interesting papers were listed on the program for this Section and two demonstrations which aroused considerable interest, namely: "The Five Year Brood Record of a Single Queen" by W. J. Nolan; "Waxworm Fumigation Experiments" by F. B. Paddock; "Federal Honey Grading Rules" by E. L. Sechrist and "The Fertilization and Hibernation of Queen Bumblebees under Controlled Conditions" by T. H. Frison, were of special interest. The Chairman gave an interesting paper on "Certain Phases of Apicultural Research in the United States" which was well received. An interesting paper was given during the evening by Dr. E. F. Phillips, Ithaca, N. Y., entitled: "Some Things I Heard and Saw while Visiting Bee Keepers and Their Societies in Europe in Summer of 1926."

The observations by Dr. Phillips were most interesting. Two features of the program of this Section were demonstrations on the artificial insemination of queen bees by Mr. Lloyd R. Watson and on "The Relative Sensitivity of Honey Bees to Light of Different Wave Lengths" by Lloyd M. Bertholf. The demonstrations made were very striking.

Two interesting conferences were held—one on Wednesday afternoon on arsenical residues on fruit, which was well attended and lively discussions on orchard sprays and the residues remaining on fruit under general orchard practice schedules of spraying; and one on oil sprays held Thursday afternoon. This was also well attended and considerable interest taken in the discussions that followed.

The Crop Protection Institute held its annual dinner and business meeting on Tuesday evening, December 28.

The program of the main Association opened Wednesday morning with a business session. The afternoon and evening was devoted to the session of the Section of Apiculture. The main Association meeting was continued Thursday morning ending Saturday at 11:30 a. m. with the final business session. Reports of the various committees were read and action taken, this being followed by the address of the President entitled: "International Entomology—Retrospective and Prospective." Among the striking papers was one by E. O. Essig on "Some Highlights in the History of the Development of Entomology in California;" "Hot Water Bulb Sterilizers" by C. A. Weigel; "New Control Measures for the Squash Vine Borer" by C. R. Cleveland; "Biological Factors in the Control of the Celery Leaf-Tyer" by E. D. Ball and others; "Baits More Attractive to the Oriental Peach Moth than 'Black-strap' Molasses" by Alvah Peterson; "Experiments in Control of the Rose Chafer" by J. R. Eyer and others; "Arsenical Content of Sprayed Apples" by Albert Hartzell and others; "Cyanide Dust Fumigation" by H. J. Quayle and "Termites Modify Building Codes" by T. E. Snyder. Interesting papers were also presented on Airplane dusting for Gipsy Moth Control, Airplane Dusting for Control of Hemlock Spanworm and Airplane Dusting of Sugar Cane. An interesting group of papers was also presented on the various phases of the Japanese Beetle Control work including parasites, attraction, spraying and methods of treatment of soil.

On the night of December 30 the entomologists held a dinner in the roof garden of the Hotel Walton, which was attended by 231 members and guests. The details were planned by the members of the Japanese Beetle Laboratory and a very unique entertainment was put on. Dr. W. E. Britton acted as toastmaster and called upon several past presidents for remarks. Several parodies on some of the well-known popular

songs were composed which portrayed well the humorous side of some entomological investigational projects and men. The dinner was enjoyed by all, being considered one of the most successful ever held.

Some exhibits were opened in a room close to the meeting room, which contained exhibits of the Japanese Beetle laboratory work, airplane dusting in Wisconsin, some apparatus, etc, which was available during the period of the meeting. This exhibit was in co-operation with that of the Entomological Society of America.

The extension entomologists and Insect Pest Survey held a meeting Friday evening, December 31, which was attended by more than 50 members. A very interesting paper was presented by J. A. Hyslop on the Insect Pest Survey work, in which he ably set forth the needs for new and better methods of estimating and keeping records of outbreaks of insects and damage to crops.

The business proceedings form Part I of this report and the addresses, papers and discussions form Part II.

The proceedings of the Sections of Plant Quarantine and Inspection and Apiculture will also be included in Part II.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by President Arthur Gibson at 9:50 a. m., Wednesday, December 29, 1926. About 300 members and visitors attended the sessions. The following members were present:

Ackerman, A. J., Washington, D. C.
Aldrich, J. M., Washington, D. C.
Allen, H. W., Riverton, N. J
Anderson, E. J., Colden, N. Y.
Arnold, G. F., A. & M. College, Miss.
Arnold, R. B., Richmond, Va.
Bailey, H. L., Bradford, Vt.
Ball, E. D., Sanford, Fla.
Baldwin, Roger S., Woodbury, Conn.
Barnes, D. F., Melrose Highlands, Mass.
Batchelder, C. H., Orono, Me.
Bentley, G. M., Knoxville, Tenn.
Blisard, T. G., Carlisle, Pa.
Bourne, A. I., Amherst, Mass.
Boyden, B. L., Tampa, Fla.
Britton, W. E., New Haven, Conn.
Brittain, W. H., Truro, N. S.
Broadbent, (Miss) B. M., Washington, D. C.
Bromley, S. W., Azusa, Calif.
Burgess, A. F., Melrose Highlands, Mass.
Buys, J. L., Canton, N. Y.
Campbell, R. E., Alhambra, Calif.
Cartwright, O. L., Columbia, S. C.
Caudell, A. N., Washington, D. C.
Claasen, P. W., Ithaca, N. Y.
Cleveland, C. R., Lafayette, Ind.
Collins, C. W., Melrose Highlands, Mass.
Cook, M. T., Bozeman, Mont.
Cory, E. N., College Park, Md.
Crosby, C. R., Ithaca, N. Y.
Cutright, C. R., Wooster, Ohio
Daniel, D. M., Geneva, N. Y.
Davis, J. J., Lafayette, Ind.
Dean, G. A., Manhattan, Kan.
De La Parelle, H. J., Atlanta, Ga.
De Long, D. M., Columbus, Ohio.
Dietz, H. F., Indianapolis, Ind.
Dills, L. E., Inwood, W. Va.
Doane, R. W., Stanford University, Calif.
Dohanian, S. M., Somerville, Mass.

Doucette, C. F., Santa Cruz, Calif.
Dozier, H. L., Newark, Del.
Drake, C. J., Ames, Iowa.
Drinnan, D. E., Knoxville, Tenn.
Dunavan, David, Ames, Iowa.
Dustan, A. G., Ottawa, Can.
Eddy, M. W., Carlisle, Pa.
English, L. L., Urbana, Ill.
Essig, E. O., Berkeley, Calif.
Ewing, H. E., Washington, D. C.
Eyer, J. R., North East, Pa.
Faxon, Richard, Columbus, Ohio.
Felt, E. P., Albany, N. Y.
Fenton, F. A., Florence, S. C.
Fernald, T. H., Amherst, Mass.
Filinger, G. A., Wooster, Ohio.
Fink, D. E., Philadelphia, Pa.
Fleming, W. E., Riverton, N. J.
Flint, W. P., Urbana, Ill.
Fox, Henry, Rivierton, N. J.
Fracker, S. B., Madison, Wis.
Frison, T. H., Urbana, Ill.
Gambrell, F. L., Geneva, N. Y.
Garman, H., Lexington, Ky.
Garman, Philip, New Haven, Conn.
Garthside, S., Sydney, Australia.
Gibson, Arthur, Ottawa, Canada.
Ginsburg, G. M., New Brunswick, N. J.
Glasgow, Hugh, Geneva, N. Y.
Glenn, P. A., Urbana, Ill.
Goodwin, J. C., Gainesville, Fla.
Grady, H. J., Augusta, Kan.
Graf, J. E., Washington, D. C.
Granovsky, A. A., Madison, Wis.
Grant, Dudley H., New York, N. Y.
Griswold, Grace H. (Miss), Ithaca, N. Y.
Guyton, T. L., Harrisburg, Pa.
Haack, T. T., Toledo, Ohio.
Haber, V. R., State College, Pa.
Hadley, C. H., Harrisburg, Pa.
Haeussler, G. J., Palmyra, N. J.
Hallock, H. C., Riverton, N. J.
Hambleton, J. I., Washington, D. C.
Hamilton, C. C., New Brunswick, N. J.
Harman, S. W., Geneva, N. Y.
Harned, R. W., A. & M. College, Miss.
Hartzell, Albert, Yonkers, N. Y.
Headlee, T. J., New Brunswick, N. J.
Herrick, G. W., Ithaca, N. Y.
Hinds, W. E., Baton Rouge, La.
Hodgkiss, H. E., State College, Pa.
Holdaway, F. G., Adelaide, Australia.
Holloway, T. E., New Orleans, La.
Hooker, W. A., Washington, D. C.
Horsfall, J. L., New York, N. Y.
Hough, W. S., Winchester, Va.
Houser, J. S., Wooster, Ohio.
Howard, L. O., Washington, D. C.
Howard, N. F., Columbus, Ohio.
Huber, L. L., Wooster, Ohio.
Huckett, H. C., Calverton, N. Y.
Hungerford, H. B., Lawrence, Kan.
Hutson, Ray, New Brunswick, N. J.
Hyslop, J. A., Washington, D. C.
Johannsen, O. A., Ithaca, N. Y.
Johnson, J. Peter, Riverton, N. J.
Jones, M. P., Columbus, Ohio.
Kamal, Mohammed, Riverside, Calif.
Kelsheimer, E. G., Ames, Iowa.
Kennedy, C. H., Columbus, Ohio
King, J. L., Riverton, N. J.
Kirk, H. B., Harrisburg, Pa.
Kisliuk, Max, Philadelphia, Pa.
Knull, J. N., Harrisburg, Pa.
Larrimer, W. H., Washington, D. C.
Lathrop, F. H., Washington, D. C.
Leiby, R. W., Raleigh, N. C.
Leonard, M. D., Ithaca, N. Y.
Lipp, J. W., Riverton, N. J.
List, G. M., Fort Collins, Colo.
Lowry, P. R., Durham, N. H.
Manter, J. A., Storrs, Conn.
Marlatt, C. L., Washington, D. C.
Matheson, Robert, Ithaca, N. Y.
Mathewson, A. A., Meadville, Pa.
McIndoo, N. E., Washington, D. C.
McLaine, L. S., Ottawa, Can.
Merrill, G. B., Gainesville, Fla.
Mills, A. S., Ithaca, N. Y.
Montgomery, J. H., Gainesville, Fla.
Moore, William, New York, N. Y.
Morrill, A. W., Los Angeles, Calif.
Morrison, Harold, Washington, D. C.
Mosher, Miss Edna, Brooklyn, N. Y.
Nelson, F. C., New Brunswick, N. J.
Newell, Wilmon, Gainesville, Fla.
Nickels, C. B., Clemson College, S. C.
O'Kane, W. C., Durham, N. H.

Osborn, Herbert, Columbus, Ohio.
Osburn, R. C., Columbus, Ohio.
Osgood, W. A., Durham, N. H.
Packard, C. M., Sacramento, Calif.
Parks, T. H., Columbus, Ohio.
Parrott, P. J., Geneva, N. Y.
Patch, Edith M., (Miss), Orono, Me.
Patch, L. H., Sandusky, Ohio.
Peters, H. S., Columbus, Ohio.
Peterson, Alvah, Riverton, N. J.
Phillips, E. F., Ithaca, N. Y.
Phillips, W. J., Charlottesville, Va.
Poos, F. W., Sandusky, Ohio.
Popenoe, C. H., Washington, D. C.
Porter, B. A., Washington, D. C.
Primm, J. K., Chicago, Ill.
Quaintance, A. L., Washington, D. C.
Quayle, H. J., Riverside, Calif.
Rea, G. H., Reynoldsville, Pa.
Ries, D. T., Ithaca, N. Y.
Riley, W. A., St. Paul, Minn.
Robinson, J. M., Auburn, Ala.
Rohwer, S. A., Washington, D. C.
Rosenfeld, A. H., New Orleans, La.
Rosewall, O. W., Baton Rouge, La.
Ruggles, A. G., St. Paul, Minn.
Safro, V. I., Los Angeles, Calif.
Sanders, P. D., College Park, Md.
Sasscer, E. R., Washington, D. C.
Satterthwait, A. F., Webster Groves, Mo.
Scammell, H. B., Toms River, N. J.
Schoene, W. J., Blacksburg, Va.
Scott, L. M., Washington, D. C.
Siegler, E. H., Washington, D. C.
Sherman, Franklin, Clemson College, S. C.
Simmons, Perez, Silver Spring, Md.
Smith, F. F., Willow Grove, Pa.
Smith, L. B., Riverton, N. J.
Snyder, T. E., Washington, D. C.
Spencer, G. E., Woodbury, N. J.
Stafford, E. W., Agricultural College, Minn.
Stear, J. R., Chambersburg, Pa.
Stearns, L. A., New Brunswick, N. J.
Stewart, M. A., Ithaca, N. Y.
Stockwell, C. W., Riverton, N. J.
Sullivan, K. C., Columbia, Mo.
Swaine, J. M., Ottawa, Canada.
Thomas, C. A., Philadelphia, Pa.
Trimble, F. M., Camp Hill, Pa.
Underhill, G. W., Onley, Va.
Van Leeuwen, E. R., Riverton, N. J.
Vickery, R. A., Arlington, Mass.
Wade, J. S., Washington, D. C.
Wallace, F. N., Indianapolis, Ind.
Walter, E. V., Tempe, Ariz.
Watson, J. R., Gainesville, Fla.
Webber, R. T., Melrose Highlands, Mass.
Weed, Alfred, Madison, Wis.
Wehrle, L. P., Ithaca, N. Y.
Weigel, C. A., Washington, D. C.
Wheeler, C. M., Knoxville, Tenn.
White, W. H., College Park, Md.
Whitmarsh, R. D., Wooster, Ohio.
Wood, W. B., Washington, D. C.
Worthley, H. N., State College, Pa.
Worthley, L. H., Arlington, Mass.
Zappe, Max P., New Haven, Conn.

President Arthur Gibson: Ladies and Gentlemen, and Members of the Association: It is my pleasure to call to order the thirty-ninth annual meeting of the American Association of Economic Entomologists.

We have a very large and long program ahead of us. I am going to ask all who are taking part to be brief in the presentation of their reports and to try to keep within the time limits when their papers are being presented.

The first item on the program this morning is the report of the Secretary.

REPORT OF THE SECRETARY

The membership of the Association at the time of the Kansas City meeting together with the election of new members, resignations, those dropped for non-payment of dues and losses by death since, is summarized as follows:

	Active	*Associate*	*Foreign*
Total membership, beginning of Kansas City meeting	374	390[1]	50
Transferred from Associate to Active membership, Kansas City meeting	+ 26	— 26	
	400	364	50
Members elected, Kansas City meeting		+ 78	
Re-instatements, Kansas City meeting		+ 4	
Resignations, Kansas City meeting		— 4	
Total membership, close of Kansas City meeting	400	442	50
Dropped for non-payment of dues, 1926	— 5	— 32	
Deaths recorded since last meeting	— 3	— 3	
Total membership, beginning of Philadelphia meeting	392	407	50
Grand Total	849		
Net gain during 1926	35		

[1]Last report showed 386 associate members—should be 390.

E. A. Hartley, an active member, died from an acute attack of appendicitis October 15, 1926, at the age of 33. Prof. Hartley graduated from Oregon Agricultural College and later studied at Ohio State University. At the time of his sudden death he was teaching Entomology in the New York State College of Forestry.

Dr. Henry Skinner, Vice-president of the Philadelphia Academy of Natural Sciences, entomologist and physician, and an active member of this Association, died May 30, 1926, aged 65 years. He had been connected with the above museum for a long period of years.

D. B. Young, an active member, died suddenly at Albany, N. Y., April 5, 1926, aged 66 years. He served for nearly 25 years as Assistant State Entomologist of New York. He was also curator of insects in the State Museum at Albany.

Harold W. Fitch, an associate member, last residing at Claremont, N. H., died May 16, 1926. He studied at Cornell University and was later connected with the Niagara Sprayer Company located at Grand Rapids, Mich.

John A. McLemore, William M. Mingee, Junior Entomologists, U. S. Bureau of Entomology, employed by Division of Truck Crop Insect Investigations, Sweet Potato Weevil Eradication, were foully murdered near Picayune, Miss., On February 18, 1926. Both men were graduates of Mississippi A. & M. College.

The 11th annual meeting of the Pacific Slope Branch was held June 17, 1926, at University of California, Berkeley, and June 18 at Mills College, Oakland, Calif. The meeting was well attended and the proceedings published in the October JOURNAL.

The Cotton States Entomologists convened February 3-5, 1926, at Biltmore Hotel, Atlanta, Ga. This was the first meeting of this body since becoming a Branch

of this Association at Kansas City, December 30, 1925. The meeting was well attended and the proceedings published in the August number of the JOURNAL.

In March 1926, Dr. E. P. Felt was chosen by the Editorial Board to represent this Association on the Editorial Board of the American Yearbook.

Common names of insects approved for General Use by the American Association of Economic Entomologists was printed in the JOURNAL, June 1925, and a supplement to the above list was printed in October 1926.

Five hundred separates of each of these lists were printed—25 cents being charged for the main list and 15 cents for the supplement. Sales have been rather small and the amount received has been credited to the Association fund.

JOURNAL OF ECONOMIC ENTOMOLOGY

The volume of the JOURNAL for the past few years contained:—

520 pages in 1921;
446 pages in 1922;
568 pages in 1923;
693 pages in 1924;
872 pages in 1925 and
895 pages in 1926

an increase of 23 pages during the past year and 375 pages in the last six years. The size of the volume has steadily increased during the past six years without it having been necessary to increase the cost of subscriptions. The steady annual gain in membership each year in the Association adds materially to the subscription list. There is a substantial balance in the treasury and it is still possible to further increase the size of the volume on the assumption that printing prices remain about the same as during the last two years. The size of the volume and quality of the matter contained therein together with the fair price for subscriptions is satisfying to subscribers.

Complete sets of the JOURNAL are still obtainable excepting No. 2 of Vol. 1 which is out of print. Volumes 8, 11 and 18 have been selling for $4.00 and Volume 12 for $5.00. It has been necessary to advance the price of Volume 18 to $4.00 because of an error by the printer in printing less than the number ordered. On foreign orders 50 cents additional is charged for postage.

Some new subscriptions have been secured during the year by members who also have co-operated and assisted generally in securing new members which results in added subscriptions.

The following table shows the total domestic and foreign subscribers in 1913, 1922, 1925 and 1926.

	1913	*1922*	*1925*	*1926*
Alabama	3	12	9	7
Arizona	7	6	10	14
Arkansas	2	6	5	5
California	34	63	95	112
Colorado	7	14	15	16
Connecticut	10	20	16	19
Delaware	3	3	5	6
Dist. of Col.	50	53	56	60
Florida	7	20	22	27
Georgia	6	9	12	13
Idaho	2	4	5	8
Illinois	30	28	33	36
Indiana	16	13	14	15
Iowa	5	12	16	17
Kansas	16	17	22	23
Kentucky	4	6	4	4
Louisiana	12	13	17	22
Maine	5	5	9	9

	1913	1922	1925	1926
Maryland	11	10	12	11
Massachusetts	48	83	75	70
Michigan	15	12	14	15
Minnesota	10	14	16	15
Mississippi	4	25	29	32
Missouri	8	13	15	17
Montana	5	9	11	10
Nebraska	3	2	5	5
Nevada	1	2	2	3
New Hampshire	4	7	10	11
New Jersey	14	23	30	38
New Mexico	3	3	2	3
New York	52	61	84	89
North Carolina	6	9	11	14
North Dakota	0	1	2	1
Ohio	22	33	47	50
Oklahoma	2	4	5	7
Oregon	10	11	12	18
Pennsylvania	18	39	48	43
Rhode Island	3	2	5	5
South Carolina	4	1	14	13
South Dakota	1	2	2	2
Tennessee	6	11	13	12
Texas	16	25	26	32
Utah	8	13	11	10
Vermont	1	1	2	2
Virginia	7	15	19	18
Washington	8	12	13	12
West Virginia	5	5	7	6
Wisconsin	6	15	17	18
Wyoming	0	1	2	4
Total for U. S.	520	768	926	999
U. S. Possessions	26			
Hawaii		11	10	11
Panama & Virgin Islands		2	3	3
Philippines		5	3	4
Porto Rico & Cuba		6	10	13
Canada	27	43	42	50
Foreign	132	163	245	257
	705	998	1239	1337

It will be noted from the above table that a gain of 98 subscriptions was made during 1926 against 115 in 1925—three-quarters of the gain of the current year having come from the United States.

Index to the Literature of American Economic Entomology, I and II

The accounts of these two volumes have been combined since June 1925 at which time all indebtedness to the Association had been made up. The sales for these numbers have been limited during the year owing to the fact that the price is rather high and the demand pretty well supplied. There is still remaining on hand a goodly supply of copies for sale.

From this combined account $675.00 was loaned in 1925 for publication of Index III, none of which has yet been paid back. There is now a balance of $346.31 in this account. (See financial statement.)

Index to the Literature of American Economic Entomology III

In my report of 1925 it was stated that $1,675 was borrowed from Association and Journal accounts to assist in financing the publication of Index III. During the current year $100 has been returned to the Association thereby canceling its indebtedness. Also $400 was returned to the Journal account. The financial statement shows the details of this fund.

The sales for this Index have been fairly good during the year but it will probably require two more years before the three Indices as a whole will be free from indebtedness. There is still on hand a liberal supply of copies of this Index.

Advertisement of our publications is run in each issue of the Journal.

Permanent Fund

In accordance with instructions from the Executive Committee, $500 was transferred from the Association Fund to the Permanent Fund. The interest on Liberty Bonds and on Savings Bank deposits has been credited to this fund, as shown in the financial statement. No applications for life membership have been received during the year which would ordinarily be accredited to this fund.

Association Statement

Balance in Treasury, December 7, 1925		$ 887.64
Amount received from dues and separates		1256.77
Amount received from bank interest		20.00
Amount received from loan to Index III		100.00
Paid—Stenographic Report, 1925	$ 201.97	
Postage	72.20	
Programs and Notices	19.41	
Supplies and Stationery	17.97	
Telegrams and Express	14.78	
Returned Checks and Collection charges	6.65	
Expenses of Pacific Slope Branch	13.40	
Funds transferred to Permanent Fund	500.00	
Secretary	100.00	
Clerical work, Secretary's Office	52.25	
Miscellaneous Expenses, Secretary's Office	4.50	
Binding	6.00	
Mimeographing	5.00	
Legal Fees	5.00	
	$1019.13	
Balance, December 3, 1926	1245.28	
	$2264.41	$2264.41

Balance, Deposited in First National Bank, Malden, Mass.

Journal Statement

Balance in Treasury, December 7, 1925		$2118.25
Amount received from subscriptions, reprints, advertising, etc.		5065.36
Amount received from loan to Index III		400.00
Amount received from bank interest		55.42
Paid—Postage	$ 249.10	
Printing	3445.56	
Programs and Notices	10.00	
Supplies and Stationery	36.90	
Half-tones and engravings	286.47	
Telegraph & Express	8.50	
Returned Checks	6.50	
Editor	200.00	
Clerical Work, Editor's Office	95.00	
Secretary	100.00	

Clerical Work, Secretary's Office		52.25	
Miscellaneous Expenses, Secretary's Office		8.08	
		$4498.36	
Balance, December 3, 1926		3140.67	
		$7639.03	$7639.03
Balance, Deposited in First National Bank, Malden, Mass.	$2616.91		
Balance, Deposited in Melrose Trust Company, Melrose, Mass	523.76		
	$3140.67		

INDEX I AND II

Balance in Treasury, December 7, 1925		$ 60.06
Received from sales		283.00
Interest on Deposits		12.00
Paid—Postage	$ 8.75	
Balance, December 3, 1926	346.31	
	355.06	$ 355.06

Balance, Deposited in First National Bank, Malden, Mass

INDEX III

Balance in Treasury, December 7, 1925		$ 35.11
Interest on Deposits		3.19
Amount received from sales		497.68
Paid—Postage	$ 12.64	
Payment on loan from Association	100.00	
Payment on loan from Journal	400.00	
Balance, December 3, 1926	23.34	
	$ 535.98	$ 535.98

Balance, Deposited in First National Bank, Malden, Mass.

INDEBTEDNESS OF INDEX III

Index III owes Indices I and II	$ 675.00
Index III owes JOURNAL	500.00
Total indebtedness	$1175.00

PERMANENT FUND

Deposit, Melrose Savings Bank, December 7, 1925	$1789.01
Interest on Deposits	67.66
Interest on Liberty Bonds	65.88
Paid into Permanent Fund from Association	500.00
Deposited, Melrose Savings, Bank, December 3, 1926	$2422.55

4¼% Liberty Bonds	1600.00	
GRAND TOTAL	$4022.55	

SUMMARY

Balance in Indices I and II Account, December 3, 1926	$ 346.31
Balance in Index III Account, December 3, 1926	23.34
Balance in Journal Account, December 3, 1926	3140.67
Balance in Association Account, December 3, 1926	1245.28
GRAND TOTAL	$4755.60

Respectfully submitted,
C. W. COLLINS, *Secretary*

Voted that the report be accepted.

PRESIDENT ARTHUR GIBSON: The next is the report of the Executive Committee.

REPORT OF THE EXECUTIVE COMMITTEE

The Cotton States Branch of the Association held its first meeting at Atlanta, Georgia, on February 3, 4, and 5, 1926. Prof. E. N. Cory, delegated by the President, represented the parent Association at this meeting.

Your President attended the 11th annual meeting of the Pacific Slope Branch, held at Berkeley and Oakland, California, on June 17 and 18, 1926. Other members of the Executive present at the meeting were First Vice-President, Carl J. Drake and Second Vice-President W. B. Herms.

At the request of the Secretary, the President secured the approval of all of the members of the Executive Committee to transfer the sum of $500. to the permanent fund of the Association.

As recommended in the report of the last Executive Committee, the President appointed George A. Dean (Chairman), D. J. Caffrey, J. J. Davis, Carl J. Drake and L. Caesar as an advisory committee on research work on the control of the European corn borer, such committee to convene with a similar advisory committee appointed from among the members of the American Society of Agronomy.

At the Kansas City meeting, one year ago, a resolution was adopted approving of the appointment of a standing committee on Insect Pest Survey. Your President, therefore, appointed as members of such committee the following: C. R. Crosby, (Chairman), L. A. Strong, R. W. Harned, R. A. Cooley and J. M. Swaine.

One year ago, too, it was resolved to form a standing committee on programme consisting of three members, to confer with a similar committee of the Entomological Society of America, regarding improvements in our programmes. The following committee was duly appointed: A. F. Burgess, (Chairman), W. E. Britton, and C. H. Hadley.

The resolution adopted at the Kansas City meeting regarding the appointment of a committee to bring together information on arsenical residues on fruits, resulted in the appointment of the following committee: W. B. Herms, (Chairman), Leroy Childs, and A. J. Ackerman.

With reference to the proposal to hold the Fourth International Congress of Entomology in the United States in 1928, your President appointed a committee of four

to consider financial and other arrangements. The personnel of this committee is L. O. Howard, (Chairman), Herbert Osborn, J. G. Needham and W. J. Holland.

As recommended in the Report of the Executive Committee presented at the Kansas City meeting, your President appointed S. I. Kuwana, of Yokohama, Japan, to represent the Association at the Third Pan-Pacific Science Congress held at Tokyo, October 27 to November 9, 1926.

At the last annual meeting, recommendations regarding delinquent members were proposed by the Committee on Membership. These, however, were referred to the incoming Executive Committee. The recommendations have been duly considered and a notice indicating action taken was published by your Secretary in the April issue of the JOURNAL OF ECONOMIC ENTOMOLOGY.

The First National Congress of Soil Science will be held at Washington, D. C., June 13 to 22, 1927. Our Association has been requested to send delegates to this Congress; your Committee would therefore recommend that the incoming President appoint two delegates to co-operate with the Organizing Committee in making the necessary arrangements, and carrying out the plans for the meeting of the Congress.

It has been the practice as the result of an agreement between the Association and its Branches and Sections, to nominate as Second, Third, Fourth and Fifth Vice-Presidents, the Chairmen of the various Branches and Sections, which action makes them members of the Executive Committee, in the opinion of the present committee it would seem that a better continuity of effort in future would result if the Secretaries of the Sections were also members of the Executive Committee. Regarding future members of the Executive, your committee therefore recommends for your consideration the following change in the constitution: Article III, Section I, officers—insert the words "and the Secretary of each branch or section" after the word "officers" on line 5.

The Executive Committee have audited the books of the Secretary and found them to be correct, and proper endorsement has been made in the cash book.

Respectfully submitted,

ARTHUR GIBSON J. I. HAMBLETON
C. J. DRAKE W. E. HINDS
W. B. HERMS C. W. COLLINS
L. A. STRONG *Committee*

Voted that the report be accepted and the recommendations adopted.

PRESIDENT ARTHUR GIBSON: The next is the report of the Representative to the National Research Council.

REPORT OF THE REPRESENTATIVE TO THE NATIONAL RESEARCH COUNCIL

The National Research Council has formed eleven divisions as a means of covering the field of science. Of these divisions the one entitled, "Division of Biology and Agriculture," includes the field covered by the work of this society.

On July 1st, 1925, the membership of the Division of Biology and Agriculture included ten members at large, thirteen representatives of societies, three liaison connections, a chairman, vice-chairman and a retiring chairman, providing, of course, that the chairman, vice-chairman, and retiring chairman do not serve also as

members in any of the preceding groups. Apparently the total possible number of representatives, (29), was thought to have proven unwieldy and an effort was set on foot looking toward reorganization of the division to the end that the number of members might be materially reduced and the efficiency thereby increased. Early in 1925 a committee was at work on this project. It has continued its work during 1926 and the division representatives on April 25th, 1926, approved the proposed reorganization. This reorganization, through the medium of combining societies for representation purposes, has produced a plan which reduces the membership of the division from a possible twenty-nine to a possible seventeen. It may be of interest to you to see the proposed combination of societies and the following table will serve to cover this point.

At Present		Proposed	
Name of Society	Number of Representatives as members of division	Name of Society	Number of Representatives as members of division
Botanical Society of America	1	Botanical Society of America	1
American Society of Zoologists	1	American Society of Zoologists	1
American Association of Animal Production	1	American Association of Animal Production	1
American Dairy Science Association	1	American Dairy Science Association	
		Poultry Science Association	
American Society of Agronomy	1	American Society of Agronomy	1
American Society for Horticultural Science	1	American Society for Horticultural Science	
Society of American Foresters	1	Society of American Foresters	
American Phytopathological Society	1	American Phytopathological Society	1
Society of American Bacteriologists	1	Society of American Bacteriologists	
Ecological Society of America	1	Ecological Society of America	1
American Genetic Association	1	American Genetic Association	
		The United Genetics Sections of the American Society of Zoologists and the Botanical Society of America	
		American Physiological Society. Physiological Section of the Botanical Society of America. American Society of Biological Chemists.	1
American Association of Economic Entomologists	1	American Association of Economic Entomologists	1

In cases where societies are combined it is proposed that each society shall designate an elector and that the electors from the societies which are grouped together shall choose from among themselves or from the membership of one of the constituent societies the group representative in the division.

This reorganization is thus seen to reduce a number of society representatives in the division from thirteen to eight. The number of members at large is reduced from ten to six making all told, with a chairman, vice-chairman, and retiring chairman, a total of seventeen.

So far as your representative can see, this reorganization, in so far as it affects the American Association of Economic Entomologists at all, affects that society favorably. It is your representative's understanding that this plan of reorganization of the Division of Biology and Agriculture, which was approved by the composition of the division on April 25th, 1926, is now up for adoption by the constituent societies.

Your representative, on the basis of his brief experience in this work, would like to offer a suggestion for your consideration, namely, that the representative of the American Association of Economic Entomologists to the National Research Council, serving as a member of a Division of Biology and Agriculture, be given a term of three years as is a common practice in most of the other constituent societies. This will provide for continuity of effort and should automatically give to the society more influence in dealing with division matters.

THOMAS J. HEADLEE,
Representative of the American Association of Economic Entomologists to the National Research Council

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: The report of the Committee on Policy is next.

REPORT OF THE COMMITTEE ON POLICY

The personnel of the subcommittees during the current year is as follows:

Technical Training and Research: Messrs. Headlee, Swaine and Ruggles.
Regulatory and Control: Messrs. Burgess, Gibson and Collins.
Insecticides: Messrs. Parrott, Headlee and Haseman.
Publicity: Messrs. Collins, Felt and Burgess.

At the last annual meeting it was voted that the report of the Committee on Endowment be accepted with the exceptions of Sections 1 to 6 which were referred to the Committee on Policy. That differences of opinion prevail is suggested by the foregoing action, and these apparently have arisen because of some doubt relative to future policy with respect to the administration of the funds of the Association and the financial support of the JOURNAL OF ECONOMIC ENTOMOLOGY. Whatever uncertainties may exist in these respects, they may be easily overcome by a few changes in the wording of the original.report. Acting on the principle that the administration of the funds and business matters of the Association should be directed by the Executive Committee, the Committee on Policy recommends that the original report be modified as follows:

In place of Section 1 which reads "That the Secretary be authorized to transfer from the Association fund to the Permanent fund each year, such moneys as are not required to meet ordinary running expenses" substitute:

Section 1. That the Secretary shall transfer from the various funds of the Association to the Permanent fund each year such moneys as are approved by the Executive Committee.

Section 2. That the interest on all deposits be transferred annually to the credit of the Permanent fund.

Section 3. That members be urged to become life members, and to facilitate payment of the life membership fee payments be made as follows: Full payment $100.00; 2 payments to be made annually $52.00; 3 payments to be made annually $36.00; 4 payments to be made annually $28.00; 5 payments to be made annually $23.20; each member to be credited with life membership after full payment has been made. It is of course understood that life membership can be conferred only after favorable action by the Membership Committee and approved by the Association, and this membership, like any other class, may be terminated by the Association for unprofessional conduct without the return of the fee.

That Section 4 of the original report be omitted.

That Section 5 of the original report be listed as Section 4 and changed to read:

That the Association create a Board of Trustees for the Permanent fund which shall have charge of all moneys placed in this fund and shall be responsible for their proper investment. It shall make disbursements from this fund subject to the approval of the Association and shall make a report at the annual meeting. This fund shall be audited annually. The Board shall consist of the President of the Association, the Secretary, and three members elected for a term of three years, one member retiring annually. The terms at the first election shall be for one, two, and three years, so as to make the retirement requirement effective. The Board shall select its own chairman.

That Section 6 of the original report be listed as Section 5, which reads:

That the present committee be discharged and a new committee be appointed by the incoming President, to take charge of raising the endowment. It is recommended that the new committee designate a member in each state to secure funds for this purpose.

There is still great need of emphasizing the fundamentals in the development of life and their practical application to economic entomology, since a more general appreciation of these means a better understanding of scientific work as a whole and is bound to eventuate in widespread and more satisfactory support. Since there is no more effective way of presenting scientific truths than through personal conversation, entomologists are therefore urged to use their opportunities to the fullest possible extent.

The need of more generous support for systematic work and investigations along the line of pure science may frequently be presented very acceptably in connection with discussions of economic projects and the connection between the two should be pointed out on every possible occasion.

The reports of the subcommittees on insecticide machinery and on lubricating oil emulsions were approved and will be printed in a future number of the Journal of Economic Entomology. Since the latter summarizes the more important facts obtained by a large number of workers during the past year and, since there is much interest in the lastest developments of oil sprays, it has been mimeographed so that the information may be readily available to members of this Association.

In view of the many problems involving factors of regional aspects which are receiving the attention of federal workers as well as an increasing number of state entomologists, the Committee on Policy desires to point out that definite benefits would be derived by a closer correlation of efforts. According to present state and national policies, it not infrequently happens that separately organized units are engaged in the same problem with little or no knowledge of other workers in the same field or of the relationship of their various activities to the undertaking as a whole.

It is in overcoming such difficulties that regional conferences can render great service. These enable the different individuals to know each other, promote or develop the spirit of mutual helpfulness, afford a clear definition of the problem, reduce unnecessary duplication of effort and permit a more accurate understanding of state and federal aims relative to financial support. Not only does a need exist for regional cultivation with a group interest at work on problems of outstanding importance, but in some states at least larger provision should be made for funds to enable more frequent consultation between individuals and groups of workers. With certain problems there is little doubt that efforts would be more productive if research workers in entomology would plan for better coordination of efforts and endeavor to operate more as regional units rather than as distinctly separate state and federal units.

That there is some question of the competency of entomological research as conducted at present to furnish satisfactory solution of the problems created by certain injurious insects is indicated by the growing feeling of dissatisfaction with the unbalanced state of knowledge relative to the fundamental principles governing insect life and the opinion that is gradually crystallizing relative to the need of purely fundamental investigations on parasitism, insect physiology, insect ecology, and insect toxicology of inorganic and organic chemical compounds.

Investigational and experimental activities as ordinarily pursued are contributing much to the quality of our knowledge, but it is not so clear that they are adding materially or in the proportion desired to the quality of our knowledge. The foregoing subjects are of fundamental importance both from the point of view of constructive science and from the application of science to human welfare. If not nearly untilled fields, they are surely imperfectly tilled and in competent hands they may prove productive. The fact that we know so little of their potential wealth does not mean that we should always remain in the dark. It would surely be an important and timely thing to attempt to round out our knowledge of insect life by starting intensive and concerted work along the proposed lines. Theory is sound in proportion to its generalizations, but in the absence of facts generalizations can be but imperfect. When the more important facts are firmly established we may perhaps be able to recast many of our theories relative to insect control.

Realizing the importance of the foregoing considerations the Committee on Policy, believing that the time is ripe for taking a progressive step, asks the authority of the Association to secure the opinion of its membership relative to the following questions:

1. What in your opinion is the value of training in Botany, Chemistry, General Zoology, Physics and General Physiology in the technical preparation for research in Economic Entomology.

2. From the standpoint of advancement in methods of insect control, what benefits would likely accrue from the establishment of a great entomological research organization devoting its energies to purely fundamental investigations in such fields as parasitism, insect physiology, insect ecology and toxicology of inorganic and organic compounds?

3. In your judgment which is the better policy—to foster a central research organization or to use the influence of the Association in encouraging members of the staffs of the higher institutions of learning, who are capable of conducting productive research along the desired lines?

In the absence of definite data relative to the attitude of our membership and the opinion of others whose views relative to such matters deserves serious consideration, it is not clear at the present time what disposition should be made of the results of this survey. If the opinions generally favor further action, this much is true, that a start has at least been made and the nature and extent of the various steps necessary to secure the desired aims are matters which may well be held in abeyance for future consideration.

P. J. PARROTT, *Chairman*	ARTHUR GIBSON
A. G. RUGGLES	THOMAS J. HEADLEE
C. W. COLLINS	A. F. BURGESS
E. P. FELT	J. M. SWAINE

Committee

Voted that the report be adopted.

At the Thursday morning session, after J. A. Manter read his paper on "Charts and Forms as Aids in Teaching Economic Entomology," there was some discussion with reference to the methods of teaching entomology in the various colleges and universities. A feeling was expressed that this Association should have a committee to formulate some program and the more progressive colleges and universities would be glad to avail themselves of the Association's recommendations. It was also brought out that there seems to be no standards of methods used in the various colleges in teaching entomology, a great deal of individuality apparently existing in the methods pursued. After the members were finally informed that a sub-committee of the Committee on Policy ordinarily cares for matters of this kind, President Gibson suggested that the whole matter be referred to the Committee on Policy.

PRESIDENT ARTHUR GIBSON: The next is the report of the Trustees of the Crop Protection Institute.

CROP PROTECTION INSTITUTE

REPORT OF CHAIRMAN OF BOARD OF GOVERNORS BY W. C. O'KANE

Activities of the Crop Protection Institute in 1926 have continued along substantially the same lines as those followed in the last four or five years. The Institute is administering various investigational projects, as noted below, and is publishing the results where conditions warrant publication. The scope of its work is gradually increasing, as more and more industrial organizations entrust it with funds for the prosecution of research.

Direction of the Institute's activities rests with the Board of Governors, three of whom are named by the American Association of Economic Entomologists, three by the American Phytopathological Society, two by the Association of Agricultural Chemists, and one by the National Research Council. The members of the Board for the year just closed have been as follow:

Prof. P. J. Parrott, Geneva, N. Y.	Dr. M. F. Barrus, Ithaca, N. Y.
Dr. N. J. Giddings, Morgantown, W. Va.	Mr. W. P. Flint, Urbana, Ill.
Dr. I. E. Melhus, Ames, Iowa.	Mr. Paul Moore, Washington, D. C.
Prof. W. C. O'Kane, Durham, N. H.	Dr. B. L. Hartwell, Kingston, R. I.

Dr. H. J. Patterson, College Park, Md.

The officers of the Board for the past year have been W. C. O'Kane, Chairman, Durham, N. H., Paul Moore, Secretary, Washington, D. C.

In the course of the year, and in accordance with the constitution, the Board of Governors established a separate depository for the funds of the Institute and elected the secretary, Paul Moore, as treasurer. For a period the Bursar of the National Research Council has acted as treasurer. The change indicated was made to facilitate the work of the Institute and does not lessen the helpful relationships that exist with the National Research Council.

Active projects on hand are as follows:

The copper investigations, which were begun in April 1925, with funds supplied by copper refiners, have continued with headquarters at the Boyce Thompson Institute, at Yonkers, N. Y., and with Dr. Frank Wilcoxon as investigator. Some interesting new copper compounds have been worked out, which promise to be of value as fungicides and which will be put to field tests the coming season.

The crown gall studies, supported by the American Association of Nurserymen and an independent committee of nurserymen, with additional funds supplied by the Iowa State College and the University of Wisconsin, have continued, with headquarters at Madison and Ames. The investigators employed have been: Dr. A. J. Riker, Mr. L. W. Boyle, Dr. J. H. Muncie and Mr. M. K. Patel. In the course of the present year an appropriation assigned to the Department of Agriculture became available for certain phases of this work, and the organization of the work was rearranged accordingly. The American Association of Nurserymen again voted funds which the Institute is administering.

The study of seed-borne parasites, supported by funds supplied by the Bayer Company, Inc., with Dr. C. R. Orton in charge, continued through the year, with headquarters at the Boyce Thompson Institute.

A second project undertaken on behalf of the Bayer Company, Inc., and supported by a further appropriation, includes investigations of thallium and mercury compounds as insecticides and rodenticides. Headquarters of this are at the Boyce Thompson Institute and the investigator is Dr. J. L. Horsfall. This work began in August.

A detailed study of the properties of Flit, a spray manufactured by the Standard Oil Company of New Jersey, continued through the year, with headquarters in New Brunswick, N. J., and Mr. Franklin C. Nelson as investigator. Interesting information as to the insecticidal properties of various materials is accumulating.

A renewal of contract was made with the Miner Laboratories of Chicago, on behalf of the Quaker Oats Company, for a study of furfuramid and related compounds. Necessary funds have been made available and the work will start early in the coming calendar year, with headquarters at Ames, Iowa.

An investigation of tree spray oils, undertaken on behalf of the Standard Oil Company of Indiana, has continued, with headquarters at Urbana, Ill., and additional phases at Lafayette, Indiana. The investigator is Mr. L. L. English. Fundamental information is being secured as to the relation of viscosity, emulsifying agents and similar factors to insecticidal efficiency.

A further project for the Standard Oil Company of Indiana is provided for in a contract signed in June of the present year. This work will include an investigation of the properties of Kip, a household spray, and Bovinol, a cattle spray. Headquarters of this work are at Lafayette, Ind., and the investigator is Harold G. Butler.

The Scalecide investigation, begun four years ago and supported with funds made

available by the B. G. Pratt Co., continued through the year. The investigator is J. W. Miller, located at State College, Pa. Additional phases of the work have been carried out in Illinois, under Dr. H. W. Anderson, and in Massachusetts, under Prof. A. I. Bourne. The project will be brought to a close early in the coming calendar year.

Publications of the year include the following:

Bulletin No. 8, "Colloidal Sulphur: Preparation and Toxicity."

Bulletin No. 9, "Suggestions on the Preparation of Apple Grafts."

Bulletin No. 10, "The Effectiveness of Various Fungicides in Controlling the Covered Smuts of Small Grains."

MR. L. O. HOWARD: I wonder if Professor O'Kane would give us just a little information about the appointment of the bursar of the Research Council.

MR. W. C. O'KANE: The Institute had its own treasurer when it was organized. Then for the convenience of disbursement of funds, the treasuryship was turned over to the bursar of the National Research Council, and then because of the work made necessary by examination of numerous committees and by various lesser matters of that kind, it seemed advisable to Dr. Kellogg and to Mr. Dunn and to the Board of Governors of the Institute to go back to the former plan and maintain an independent treasuryship. That was already provided for in the constitution, so we simply switched back again.

I should add that the relationship with the Research Council remains unaltered. That was the critical point in so far as the Institute was concerned. We wish there shall be no change. That was the wish also of Dr. Kellogg and Mr. Dunn and the other members of the National Research Council, and that is understood. They still have representation on the Board of Governors and still house the secretary and treasurer and still maintain an advisory committee in close relationship with the Institute.

MR. R. B. ARNOLD: What is the advantage in an industrial organization of undertaking a research through a crop protection institute? We are interested in research now in relation to nicotine. I wondered where this Crop Protection Institute might help us.

MR. W. C. O'KANE: If there is no advantage derived from spending the money through the Crop Protection Institute, we hope nobody will do it that way, because individually we have plenty of work on hand. It appears there has been advantage in various cases and of a material nature. I am quite sure that those who have been spending the money that way wouldn't have done so otherwise. For instance, when The Standard Oil Company of Indiana was about to undertake a second

project, they informed us of their wishes to do this but would not unless the Institute handled the money.

I think I should better answer the question in detail privately.

On the Board of Governors is a member from this Association, the American Association for the Advancement of Science, the Pathological Association, the Association of Biochemists and the National Research Council. If that isn't an agreeable arrangement, I don't know what could be. That gives a sort of prestige, or whatever you may call it, to the Institute and it gives an entree with the experiment station directors and university presidents which means a provision of facilities that would not otherwise be obtained in many cases. It also means a critical review of the results of any investigation which is valuable surely to the scientific men themselves as well as to the industries concerned.

There are various other matters that I would be glad to discuss later.

Voted that the report be accepted.

President Arthur Gibson: The next is the report of the Scientific Trustee, Tropical Plant Research Foundation.

REPORT OF THE TRUSTEE OF THE TROPICAL PLANT RESEARCH FOUNDATION

As representative of the Society on the Board of Trustees of the Tropical Plant Research Foundation to fill the vacancy caused by the untimely death of Dr. W. D. Hunter my election was officially confirmed and I took part in the proceedings at the April meeting of the Foundation.

For the information of members not fully acquainted with the objects of the Foundation it may be stated that it is an organization under the supervision of the National Research Council and concerned with the promotion of investigations upon the plant life of tropical regions. It receives support from various sources, especially such organizations as are interested in the development of tropical agriculture and maintains a central office at Washington and at present has a tropical laboratory for investigation of sugar cane problems at Baraguá in Camaguey Province Cuba, financed by the Cuba Sugar Club. Other projects have to do with tropical forest resources and the Foundation is ready to engage on other desirable projects when the means are available.

The entomological investigations, with which we are specially interested, have so far been connected with insects affecting the sugar crop. The entomologists on the staff of the Baraguá laboratory include the resident Director Prof. D. L. Van Dine, Mr. C. F. Stahl who is engaged especially upon a study of the insect vectors for the mosaic disease of sugar cane and Mr. Planck who is working on the sugar cane borer and its parasites.

The foundation is publishing two series of papers, one a general series intended especially for the use of the sugar growers of Cuba and one of these is devoted to the insects affecting sugar cane, prepared by Prof. Van Dine; the other series consists of reprints from scientific journals and in this series two papers have appeared devoted to the Homoptera related to sugar cane or those which may have a possible connection with mosaic transmission.

The object of our society's representation on the Board of the Foundation is obviously to provide a means for ready interchange of information, and the giving of advice when desired concerning problems connected with the entomological activities of the foundation in any of its enterprises. Your representative will be very glad to answer any questions concerning the organization and to receive suggestions as to meritorious projects or affiliations that may assist in the development of entomological science in the tropics. There is an unlimited field there for entomological research and it seems inevitable that there will be a growing demand for trained entomologists to engage in important economic studies.

HERBERT OSBORN

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: Next we will listen to the report of the Representative on the Council of the Union of American Biological Societies.

REPORT OF THE REPRESENTATIVES OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS ON THE COUNCIL OF THE UNION OF AMERICAN BIOLOGICAL SOCIETIES

The council met at Philadelphia on December 27th. The only business of importance was the reading of the report on "Biological Abstracts" by Dr. J. R. Schramm, Editor in Chief. This report will be published in full elsewhere. The plans for this great undertaking have been thoroly worked out in detail and its success is now definitely assured. It deserves the hearty support and cooperation of all members of our Association.

(Signed)
A. L. QUAINTANCE
C. R. CROSBY

Voted that the report be accepted.

PRESIDENT ARTHUR GIBSON: We will now listen to the report of the Committee on Nomenclature.

REPORT OF COMMITTEE ON NOMENCLATURE

Your Committee on Common Names begs to report that during the past year it has published in the JOURNAL OF ECONOMIC ENTOMOLOGY a supplementary list of 65 names to the first list which it published in the JOURNAL (Volume 18 No. 3, pages 521-545). This now brings the total number of names approved by the Association up to 606.

Your Committee has further considered the names of 56 additional insects which it submits herewith.

To consider these names at the present time would be tedious and we could hardly give the necessary consideration in the time available. With your permission, the Committee would suggest, that we follow the procedure of previous years, and submit this list in mimeographed form to each member of the Association for his or her consideration.

All suggestions for change of the names submitted to be in the hands of the Committee on Common Names, on or before March 1, 1927. Those names, to which less

than 5 objections have been raised to be considered as approved by the Association and published in the next volume of the JOURNAL OF ECONOMIC ENTOMOLOGY.

Your Committee now believes that, though the common names for all of our pests have not been approved by the Association, the majority of these pests most commonly referred to in literature are provided for. We found, in working over the list of common names which we are presenting to you this year, that we were reaching that group of insects for which common names have not been well crystalized in the minds of the entomological workers. We also believe that it is not advisable for the Association, to approve names for insects which are not attracting enough attention to have received vernacular names.

If it is the pleasure of the Association to continue the selection of common names for insects, it is respectfully suggested that the membership of this Committee be reduced to 5 and that it be made more representative of the agricultural regions of the United States and Canada.

Respectfully submitted,
EDITH M. PATCH, *Chairman*
ARTHUR GIBSON
Z. P. METCALF
J. E. GRAF
A. N. CAUDELL
S. A. ROHWER
J. A. HYSLOP
Committee

MR. S. B. FRACKER: I should like to inquire of the committee their policy with respect to the scientific names that are included in this list. Is it the policy of the committee to keep in touch with the systematist and recommend or publish changes in the list of scientific names as they have appeared in these lists from time to time or will appear in the future, or is it their expectation that economic entomologists will keep in touch with such changes and make their own changes in the references from time to time?

MISS EDITH M. PATCH: It will be the endeavor of the committee to keep in touch with them.

MR. S. B. FRACKER: If it is the policy of the various economic entomologists to use both the common and scientific names as given in these lists, I would like to suggest that changes of this kind be recommended to this body for adoption when the Committee on Nomenclature is convinced that the changes in the scientific names are sound.

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: The next is the report of Editorial Board (A—Index to Economic Entomology, B—Biological Abstracts).

REPORT ON THE INDEX TO ECONOMIC ENTOMOLOGY AND UPON CO-OPERATION WITH BIOLOGICAL ABSTRACTS

It has been the feeling of your committee in relation to the Index of American Economic Entomology, that inasmuch as Biological Abstracts has just begun publication it is early to make definite plans in relation to bringing the Index down to-date, and with this in mind we were inclined to keep the matter open another year. It has recently come to the knowledge of the committee that conditions in the Federal Bureau of Entomology are exceptionally favorable for the compilation of another Index, and if the association wishes to continue the Index series, an early decision is advisable. It may be noted in this connection that the Index is an exceedingly compact, serviceable publication which has been available to members of the association at the very nominal price of $1.00 for each year covered in the last two issues. Biological Abstracts while it occupies a much larger field and renders a correspondingly greater service, also costs considerably more. The situation has been briefly summarized and the problem may well come up for discussion and possible decision

There has been close co-operation between your committee and representatives of Biological Abstracts in determining matter which should be abstracted and the selection of individuals to take charge of various phases of economic entomology. Since this committee may be able to render further service along these lines, it is recommended that it be continued as an organization which may function in the case of need.

Respectfully submitted,
E. P. Felt
C. W. Collins
W. E. Britton
Committee

Voted that the report be adopted.

President Arthur Gibson: I will ask Dr. Felt to read the next report of the Committee on United States National Museum.

REPORT OF THE COMMITTEE ON THE NATIONAL MUSEUM

Entomology has developed wonderfully in the past twenty-five years and in its practical aspects finds larger applications in agriculture, forestry and the prevention of disease. There is probably no branch of natural history more intimately related to human welfare. This expansion has created insistent demands for accurate identifications in many groups previously regarded as of little importance and for the ready determination of insects in all stages. In the judgment of the committee, the taxonomic work of the country has not developed on a scale warranted by our economic needs. There is no natural group presenting greater difficulties, and as a consequence requiring more intensive and prolonged training for the most efficient service and yet it is much easier to obtain an appropriation for a definite economic project than to secure funds for the adequate development of the fundamental work in our museums. The time must come when the importance of taxonomic work will be generally appreciated. This can be brought about only by repeated emphasis of the above by those acquainted with the facts.

Private workers are depositing their types or noteworthy collections in the Na-

tional Museum. This cannot be commended too highly. Other entomologists, especially those in institutions without a permanent museum policy are urged to adopt a similar course and at least deposit paratypes in the National collection. It is believed that further co-operation in the exchange of either types or paratypes or of material upon which revisionary papers are based, might be practiced advantageously between some of our large institutions and the National Museum. The latter, now has a tray filing system which makes all such material readily available. The general welfare of science dictates the maintenance of a few large entomological collections and on this continent it is believed that the United States National Museum and the Canadian National Museum should be the preferred repositories.

The gift to the United States National Museum of the extensive collection of water beetles by John D. Sherman, Jr., accords with the policy outlined above. The extensive Casey collection of beetles is now being labeled, transferred and installed in new steel cases, thus making it available for study.

The general and prompt service in the identification of insects given by our National Museum to official and other workers throughout the continent should be met by loyal support and any possible co-operation in securing more adequate facilities.

Respectfully submitted,
E. P. Felt
J. J. Davis
O. A. Johannsen
R. W. Harned
W. E. Hinds
Committee

Voted that the report be adopted.

President Arthur Gibson: The next is the report of the Program Committee.

REPORT OF THE PROGRAM COMMITTEE

Chairman A. F. Burgess presented the following recommendations, which had been approved by the Program Committee of this Association and of a similar committee of the Entomological Society of America in accordance with the resolutions passed at the Kansas City meeting.

1. That the preparation of the programs be left in the hands of the Secretaries of the two Societies.
2. That arrangements for the Entomological dinner be placed each year as near the middle of the week as possible.
3. That the place of the next annual meeting be left in the hands of the Executive Committee, with the suggestion that they consider the advisability of holding the annual meeting at a different time or different place from the regular meeting of the American Association for the Advancement of Science, the Executive Committee to confer with the Executive Committee of the Entomological Society of America before making a decision.
4. That before small conferences are called at the time of the annual meetings, the Secretaries of the two Societies be consulted relative to the most desirable time of holding those conferences.

(Signed) A. F. Burgess, *Chairman*
W. E. Britton
C. H. Hadley
Committee

President Arthur Gibson: This report is open for discussion.

Mr. C. L. Marlatt: I have only this thought to introduce and you may accept it for what it is worth: It has occurred to me very often in attending the meetings of this body and of other similar bodies that there is too much reading of papers. I feel rather radically on that point. I may not strike any sympathetic chord in this audience. My thought is simply that the subjects be assembled, classified (that is done now to some extent) and that the persons presenting papers on the results of special lines of work be asked to summarize those papers, put in very brief form the important results, put them clearly enough so that the members will realize what they have obtained, what they have achieved but don't give the details, don't read the paper. If possible, have them give it orally, or read it quickly, and then after the reading of the series of papers that are related, we can have time for general discussion. I think you will add to the interest of the meeting.

I know some other associations have adopted what they call the round table method, which is such as I have described. It has aroused an interest in those associations and societies that was before lacking.

I put this forward simply for what it is worth.

Mr. Glenn W. Herrick: There are two or three remarks I would like to make concerning this: In the first place I am in sympathy with Dr. Marlatt. In the second place it seems to me we might get rid of spending a whole forenoon listening to reports of committees. Those reports perhaps might be condensed a good deal. It seems like rather a waste of time to spend a whole forenoon listening to eighteen or nineteen different reports.

It was also suggested by the speaker that before we hold our meetings separately from the meetings of the American Association for the Advancement of Science, that he favors the meeting next year in Nashville, Tennessee, due to the large number of entomologists located in the South not having had equal opportunities to attend previous meetings.

Mr. Burgess stated that the suggestions made in the report were made in a way to bring out just such ideas as had been made by Dr. Marlatt and Professor Herrick and that the committee was anxious to know what the members wanted.

In regard to Professor Herrick's suggestion of saving time on reports, I suppose it would be possible for the Association to vote that the reports of these various committees be submitted to the Executive Committee and let it make a brief summary report, if the Association would like to have business done that way. That is a matter for you to consider.

Let's do the thing that will serve the best interests of the greater number of the membership.

MR. E. D. BALL: I am very certain, as the result of the discussion at the time the motion was made to appoint this committee, that the committee did not understand it or has ignored the idea that was in the minds of those people who submitted that resolution. This committee on program was to be a continuous committee which would establish more or less of a policy on program and would pick out symposium topics from year to year and probably decide on what was a symposium topic for this year and for next year and so on, and let that be known in advance so that there could be preparation. A real symposium is something that should have more than one year's preparation; as it is now, a man usually has a month or six weeks to make preparation. The major idea was that we would have more of that type of program and that this committee, by being a continuous committee and taking that into consideration, might map out a tentative future program of four or five symposia and invite people to prepare the results of their life work as a symposium program paper: then we might have invitation programs that are not symposia in which we would invite members, possibly not members of this society, to come before us and discuss topics that would be of vital interest, invite pathologists to discuss before us insect transmitted diseases from the disease standpoint, for instance. Under the provisions of this society as it is organized now, there is no possibility of that unless this committee takes it up and issues an invitation officially from this Association.

I am very sure that the functions of that committee were considered at the time the committee was appointed, and they were much more along that line than to take care of the details of the program, the assembling of papers, the printing, and all of that. It was to be a committee on permanent policy of program, that by having such a committee we could work out and get a very much stronger program than we have at the present time.

MR. A. F. BURGESS: Mr. President, I want to say if this committee has apparently ignored any of the intentions in regard to its creation, it has done so unintentionally, because the committee has striven to find out just what was wanted, just what was in the minds of the members of the Association who put through the resolution last year. We have never been able to get a very clear idea of just what was intended. I have asked numbers who were at the Kansas City meeting and couldn't get definite information. We have done the best we could under the circumstances.

If it was the intention of that resolution that this committee should continue from year to year and map out programs in advance, I want to say there isn't any committee in this Association which would have a harder job.

The program subject is one of the most difficult subjects that we have to deal with. There is no question that we are overcrowded this year.

If it was the intention of the resolution that the committee take up that type of work, then there will have to be a re-arrangement on the program right through, because there are too many papers to permit half a day or more to be devoted to a symposium. If that is what the Association would like to have, we ought to have it, and some way should be worked out so it can be taken care of.

I have quite a good many ideas on programs because I have had quite a lot of experience with them. There are a great many difficulties in making up and handling programs that lots of the members of the Association don't realize.

Dr. Hinds stated that he hoped there would be no special meeting arranged for 1927 other than the regular meeting which would be with the American Association for the Advancement of Science at Nashville, Tennessee. He also stated that it was possible and probable that the Cotton States Branch would arrange their annual meeting at the same time as this Association.

He also mentioned that the railway rates should be considered, as members get fare and a half in connection with the American Association for the Advancement of Science which this Association would probably not be able to get as a separate organization.

MR. A. L. QUAINTANCE: I agree especially with what Dr. Ball has said about the advantages of a symposium type of assembly of papers and discussion. At a symposium we all get a chance to talk. I think the membership here in recent years feel they haven't had a chance to discuss things that have been presented.

Simply to get a reaction from the membership, I move you that there be added to the instructions of the Program Committee, instructions to the effect that next year's program be arranged on the symposium basis.

There are usually at each of our meetings some five or six very prominent entomological subjects. I should think those might be arranged in the form of symposia. I would like to ascertain the feeling of the membership here on a tryout of a symposium type of program for our next meeting. I, therefore, move that that be included in the instructions of the Program Committee for next year.

Mr. A. F. Burgess: Mr: President, I would like to ask if that means the whole program should be a symposium.

Mr. A. L. Quaintance: I think it might well be tried that way. If there are a number of relating papers, they could be included in this segregation of subject matter. I would like to see a diversion back to the old type of meeting so we would have time to discuss and exchange opinions on the principal subjects at that particular time.

Mr. A. F. Burgess: I would like to call the attention of the Association to the fact that you have right in the Constitution a statement that all members have equal right to present papers on the program. If you want to do this, and I am not saying that it is not a good thing to do, amend the Constitution so you can do it and do it right.

Mr. C. H. Hadley: I want to bring out one other point in reference to what Dr. Ball has said. Unfortunately, I don't believe any member of this committee was present at last year's meeting. Judging from our conversation with a number of members who were present, I think that it was probably not clearly brought out as to just what this committee was intended to do, and I believe also the same state of affairs exist with reference to the committee from the Entomological Society of America.

I want to point out further, however, that if this committee was intended to be a standing committee, it was not listed in the program as a standing committee.

While I am thoroughly in sympathy with Dr. Quaintance's suggestion and would certainly vote accordingly, it seems to me that you will have to get your committee re-organized, re-appointed, first, because I understand that this committee automatically goes out of existence with the acceptance of its report.

Mr. C. J. Drake: I suggest we have a double program next year—run a symposium and a regular program and let the people take their choice. Have them going on at the same time. Have the regular papers read and a symposium of the major problems at the same time.

President Arthur Gibson: The Chair is getting rather mixed up. I understand there is a motion before the house that the meeting next year take the form of a symposium, but according to Mr. Burgess, that is unconstitutional and requires a change in the Constitution.

Mr. E. D. Ball: I wonder if Dr. Quaintance would accept this amendment to his motion, which would bring it in line with the Constitution: That we have one or more symposia at each annual meeting, to be arranged by this committee. That doesn't interfere with the right of every man to appear on the program.

President Arthur Gibson: Will you accept that amendment?

Mr. A. L. Quaintance: Yes.

President Arthur Gibson: We will take the vote on the amendment first. Those in favor of this amendment as proposed, signify by saying "aye;" contrary "no." It is carried.

Now a motion is in order to adopt the report of the Committee on Program, in line with this suggestion.

Mr. W. C. O'Kane: We have all presented papers before the Association and taken up too much time on details. Why can't we get down to the point of presenting the results of papers in three or four minute abstracts, combining that with symposia in which we may discuss at length and at liberty important entomological problems, thereby gaining the advantages of a program in which men present here for the first time results of work they have done and an opportunity for free discussion of big entomological problems.

Mr. C. L. Marlatt: The last speaker has very much the idea that I had in mind in my original remarks, that is, have the papers on a particular subject grouped, and then have them abstracted and limit them to two minutes. That would save eight minutes on every paper. In that way you would save enough time for discussion. By adopting in this connection the thought of abstracts, of presenting a brief summary of the reports, you would gain a lot of time. I think, then, the difficulties that have been mentioned would disappear. The papers that didn't fall into any of these symposia or general subjects would be relegated to a group by themselves to be taken up in the old form, except that they also should be presented by abstract or in a brief statement.

If it is proper, I would like to move that the committee be instructed to consider and adopt this abstract idea as well as the symposium idea, combine the two so far as the papers can be so combined, and then classify the odd papers by themselves.

The motion was carried.

A motion was then made that the report by Chairman A. F. Burgess be accepted and the committee continued to carry out the further work with respect to program.

The motion was seconded and carried.

At the final business session there was considerable discussion about the status of the program committee in that the Committee on Nominations had not included in their report the personnel of the committee for 1927. A motion was made and carried that the program committee be made a permanent or standing committee.

PRESIDENT ARTHUR GIBSON: The next is the report of the committee investigating arsenical residues on fruit.

Professor Essig read the report.

PROGRESS REPORT OF COMMITTEE TO INVESTIGATE ARSENICAL RESIDUES ON FRUITS AS THE RESULT OF SPRAY PROGRAMS

This committee is the result of a resolution adopted by the American Association of Economic Entomologists at the December, 1925, meeting in Kansas City. The committee was appointed by President Arthur Gibson under date of April 7, 1926, and consists of the following members, Mr. A. J. Ackerman, U. S. Bureau of Entomology, Washington, D. C., Mr. Leroy Childs, Hood River, Oregon, and Prof. W. B. Herms, University of California, Chairman.

Owing to great intervening distances it has not been practical for the members of the committee to meet as a body, hence correspondence has been resorted to. Each member has carried on such work as was possible in his immediate vicinity, and has exercised all possible influence in furthering the objective of the committee.

The chairman has attended several Pacific Coast meetings of entomologists at which spray programs and methods for codling moth control were intensively discussed. At one of these meetings, fortunately, two members of the committee (Herms and Childs) were present and a conference between the two was made possible. Through the splendid co-operation of President Arthur Gibson of the American Association of Economic Entomologists, and other workers in various parts, particularly the apple and pear growing sections of the Pacific Coast, the chairman has been able to accumulate a mass of material pertaining to the problem at hand. Since the results of much of this season's work are still unavailable, this report can perhaps only enumerate lines of attack that have been employed in many of the fruit growing districts of the country where codling moth control is necessary.

1. Control of the first brood of moths.
2. Making early sprays more effective.
3. Removal of residue by either mechanical or chemical means.
4. Supplemental methods.
   a. Banding trees
   b. Orchard and packing house sanitation.
   c. Baiting moths.
5. Substitutes for arsenicals.
   a. Petroleum.
   b. Sodium fluosilicate.
   c. Nicotine sulfate.

The following general conclusions and recommendations are presented at this time.

1. Although arsenicals have been used for codling moth control for a great many years, the present serious residue situation which gives no promise of lessened tension, behooves all concerned to give serious consideration to other means of codling moth control. It is the business of the economic entomologist to help the grower to produce a marketable crop. For the immediate future it appears that arsenate of lead is the only practicable insecticide which can be used with good effect in preventing codling moth injury to apples and pears. Much work has been done during the past season with other insecticides, notably oil sprays, but the results of this work as have reached this committee are either conflicting or very fragmentary or as yet incomplete,

hence no general recommendation is possible, except to urge that this experimentation be continued and that greater effort be made to coordinate the same.

2. Although the committee is not disposed to argue the question of tolerance and on the contrary recommends that the utmost endeavor be made by all concerned to meet the present requirements, it nevertheless trusts that reasonable leniency will be exercised in the administration of tolerance during this period of readjustment.

3. While some attention has been given to the parasites of the codling moth, the matter of control of this insect by this means has as yet not been thoroughly investigated. In view of the work of Flanders with egg parasites this line of investigation would seem to be highly desirable.

4. In spite of the fact that an enormous literature concerning the codling moth has accumulated based on more or less careful research, there is badly needed a modern fundamental investigation of this insect particularly in relation to ecology and sensory reactions of the several stages.

Respectfully submitted,
W. B. Herms
Chairman of Committee

Much credit is due Mr. Arthur Kelsall, Dominion Entomological Laboratory, Annapolis Royal N. S., Canada for information furnished in the preparation of this report.

Voted that the report be accepted.

As the result of a conference on codling moth sprays and arsenical residues on fruits Wednesday afternoon, December 29, a committee on resolutions relative to spray residues was appointed by President Gibson to report Thursday afternoon. The personnel of the committee is as follows: W. C. O'Kane, Chairman, T. J. Headlee, J. J. Davis, E. D. Ball and E. O. Essig.

Suggested committee to formulate plans for investigation of the codling moth from biologic and control standpoints will consist of: A. L. Quaintance, Chairman, G. A. Dean, P. J. Parrott, B. A. Porter, W. P. Flint and Leroy Childs.

Thursday afternoon the committee on resolutions relative to spray residues brought in their report.

SUPPLEMENT TO PROGRESS REPORT OF COMMITTEE TO INVESTIGATE ARSENICAL RESIDUES ON FRUITS AS THE RESULT OF SPRAY PROGRAMS

The Codling Moth Outlaw

For many years the big problem of the apple grower has been to prevent the heavy losses caused by codling moth worms in July, August and September. In order to meet this problem there has been a growing tendency to concentrate spraying efforts in the late summer months. The plan of late spraying has failed to give the improvement in control that has been expected and desired, and, also, it has resulted in objectionable amounts of spray residue remaining on the fruit at harvest.

At a recent conference of entomologists of the University of California, the State Department of Agriculture and the United States Bureau of Entomology, the following information and recommendations were prepared:

Exterminate First Brood of Worms

There are two fairly distinct broods of codling moth worms with a partial third brood in the warmer districts. The second brood worms cause the severe damage to the apple crop. The second brood are the offspring of the first brood. If the first brood could be completely killed off or practically so, there would not be enough second brood in August to do any serious harm and late spraying could be largely or entirely dispensed with. Herein lies the most promising solution of the codling moth problem.

The first brood worms hatch almost entirely during April, May and June. The program of extermination must be carried on with the utmost intensity during this period. Every measure having any value in destroying the worms should be employed. Spraying is, of course, the most effective method of destruction but if the moths are abundant as is the case in most sections of the state, other measures must also be employed.

The Calyx Spray. The calyx spray ranks with the most important spray in codling moth control. It should be applied when the petals have nearly all fallen. If the application has been unsatisfactory because of windy or rainy weather, or if there is irregularity in the blooming time of different varieties, or if worm control in the past has been especially unsatisfactory, a second calyx spray should be applied before the calyx lobes close. Use an abundance of spray and direct the force of the spray against the blossoms, using spray rods and a tower if necessary.

Cover Sprays for First Brood Worms. The first cover spray should be made before any worms begin hatching. If the weather should turn off warm after the trees bloom the first cover spray should be completed by two weeks after the calyx spray and by three weeks if the weather should remain cool. Use standard (acid) arsenate of lead at the rate of three pounds of powder or six pounds of paste to one hundred gallons of water. In the fog belt near the coast where arsenical injury occurs basic arsenate of lead should be used at the rate of three or four pounds to one hundred gallons of water. Spray thoroughly and apply an abundance of spray for the purpose of completely covering the leaves and bark as well as the apples.

The second cover spray and subsequent ones should be applied with such frequency as to keep the leaves, bark and fruit thoroughly coated with spray up until July 1. This requires that applications should be made at intervals of ten days to two weeks. Follow the same directions as for the first cover spray.

Banding for First Brood Worms. Not all first brood worms will be killed by the spray. Some will escape regardless almost of how thoroughly the spraying has been done. A large percentage of these can be captured and destroyed by placing burlap bands around the trunks of the trees about May 20. The bands should be folded to three thicknesses. The band may be held in place by driving a finishing nail diagonally into the tree and slipping over this the ends of the band. The bands should be examined and the worms destroyed every ten days throughout the summer. This should not be neglected. Rough bark should be scraped from the trunks before banding in order to cause more worms to go under the bands.

THINNING OFF WORMY APPLES. Thinning crews should be especially on the lookout for wormy apples which should be collected in bags and buried or otherwise destroyed. The picking off of wormy apples any time during May and June is worth while for every first brood worm killed may mean the saving of several apples at harvest.

CONTROLLING WORMS AFTER JULY 1. If a large number of first brood worms get by, the battle is lost. Late spraying is much less effective than the sprays made up until July 1. No sprays should be applied later than a month before the apples are to be picked.

In view of the following facts—

1. That there has been confusion as to the exact facts in cases of human disorders that were thought to be due to residues on edible products following spraying.

2. That there is wholly insufficient information as to the limits of safety in such residues.

3. That present official spray schedules have been followed over wide areas and for a long period of years with absence of manifest harmful effects to those consuming sprayed products, even though such products have been freely used.

4. That the health and safety of the public constitute a permanent consideration which must be fully safeguarded.

It is recommended—

1. That the United States Department of Agriculture call in conference representatives of the American Medical Association, a physiological laboratory such as that of Chicago University, interested State Experiment Stations, and others, together with experts in the Department, in order to plan a joint investigation that will disclose the basic facts with reference to tolerance.

2. That the United States Department of Agriculture and the State Experiment Stations undertake further studies intended to disclose new materials that may serve as adequate agents for control of injurious insects, and that a sub-committee of this committee, with Dr. A. L. Quaintance, as Chairman, be authorized to take the necessary steps toward such a program.

3. That the United States Department of Agriculture and State Experiment Stations give special attention to studies of control measures aside from applications of sprays, including such as biological control methods, orchard and garden sanitation and the like,

4. That Entomologists emphasize close adherence to authorized and conservative spray schedules.

W. C. O'KANE
E. D. BALL
J. J. DAVIS
T. J. HEADLEE
E. O. ESSIG

Committee

MR. ALBERT HARTZELL: I would like to say I am thoroughly in sympathy with these resolutions. I think what we need is a lot more work. I don't want to infer from this short paper that this represents very much of the story of arsenic. What we are trying to do is to find out a few more facts regarding arsenical residues. We hope to continue

this work over a number of years. We wish that others in other fruit districts would carry on experiments of that kind. I believe in time we will get more people to see and know where we stand, and then if we have sufficient medical data, I am quite sure that we can arrive at a position where it will be safe to use these sprays.

Voted that the resolutions be adopted.

President Arthur Gibson: Next is the report of the committee for Holding the Fourth International Entomological Congress in America.

REPORT OF COMMITTEE FOR HOLDING THE FOURTH INTERNATIONAL ENTOMOLOGICAL CONGRESS IN AMERICA

Mr. L. O. Howard: You will remember perhaps my report last year on the Zurich Congress, the third Entomological Congress, the first one having been held in Brussels in 1910, and the second one in Oxford in 1912. At the Oxford Congress there was a strong invitation from the United States, presented by Dr. Skinner, to the Congress to come to the United States in 1915, but it was overruled by the committee and the Congress was appointed for Vienna in 1915, with the understanding that the Congress would come to the United States in 1918. Then came the Great War, which interrupted everything, and there was no Congress until 1925, at Zurich.

The permanent committee expressed a desire to come to the United States in 1928. The matter was submitted to this Association at its last meeting. A committee consisting of Dr. Osborn, Dr. Holland, Dr. Needham and myself was appointed. We have been conducting negotiations throughout the past year and considering all sorts of possibilities. We met yesterday with a committee of the Entomological Society of America, and have phrased the following resolutions which we offer to you:

"*Resolved*, That the American Association of Economic Entomologists extend to the permanent committee of the International Entomological Congresses a cordial invitation to hold the Fourth Congress in the United States of America, and that Ithaca, New York, and the third week in August, 1928, be selected as the place and time.

Resolved, That your committee be continued and that it be requested to act in cooperation with a similar committee from the Entomological Society of America as a joint committee, charged with consideration of further details connected with the Congress."

L. O. Howard, *Chairman*
W. J. Holland
Herbert Osborn
J. G. Needham
Committee

Voted that the report be adopted.

President Arthur Gibson: Report of the Advisory Committee, Entomologists and Agronomists on Research and Control of European Corn Borer, is next.

THE REPORT OF THE JOINT COMMITTEE ON THE EUROPEAN CORN BORER, APPOINTED BY THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS AND THE AMERICAN SOCIETY OF AGRONOMY

The European corn borer, which was first discovered in the western infestation area of the United States in the summer of 1920, has made a natural spread until at the present time (September, 1926) the insect occurs throughout a strip of territory varying from 75 to 150 miles wide in the Lake Erie districts of New York, Pennsylvania, Ohio, Michigan, Indiana, and Ontario. Although drastic measures are being taken to place in operation every known agency to prevent the spread and to reduce the intensity of infestation, the insect is spreading in all directions at a rate of from 20 to 30 miles per year, and the infestation is increasing in intensity.

Those familiar with the habits of the corn borer and those who have observed crop losses in the principal dent corn-growing districts of Ontario, are convinced that the insect is of tremendous potentiality and ranks as one of the most alarming crop pests that has ever become established in America. Threatening as it does the corn crop of this country, upon which the great livestock industry depends for roughage and grain, the situation presents the possibility of a national calamity which calls for the keenest knowledge of the scientist, the wisest judgment of the state and government officials, and the closest cooperation of the growers.

The committee appointed to investigate the possibility of closer cooperation between entomologists and agronomists in combating the European corn borer, wishes to endorse and give its hearty approval to the efforts that have been made to prevent the spread of the corn borer and to commend those engaged in directing the research in this field for the extensive cooperative experiments now under way to develop effective means for the control of the insect. It would seem that little has been omitted in planning and conducting both the quarantine and research work. It is the purpose and wish of this committee to assist in every possible way to marshall all forces in an effort to give every possible support and encouragement to the extensive research now under way. With this purpose in mind, the committee suggests and recommends.

That the state agricultural experiment stations, the state departments of agriculture, and all other agencies interested in the welfare of agriculture give their support and encouragement to the federal governments toward a continuation of present policies in respect to quarantines and quarantine enforcement. Realizing, however, that with the continued spread of the borer, it may be necessary to modify the quarantine and scouting programs within the next few years, that scouting work in the area not known to be infested by the European corn borer, but apparently subject to infestations, be continued, and that the scouting work be extended further to uninfested areas in the large corn-producing states where such areas seem particularly exposed to infestations.

That the cooperative projects in the infested areas now under way between agronomists and entomologists of the state and federal governments to determine the best types, varieties, and strains of corn to use under corn borer conditions be continued. Studies to determine the best time to plant different sorts to escape commercial damage also should be continued. Agronomists and plant breeders should endeavor to find strains of corn which may have some natural resistance. Efforts also should be made to determine the possibility of developing strains which may have some natural resistance. Efforts also should be made to determine the possibility of de-

veloping strains which may be planted at the optimum time to escape severe infestation and yet yield profitable returns. These projects should be continued for a sufficient time to be reliable and to be conducted under different climatic conditions.

That similar projects with respect to types, time of maturing, yields, etc., be started in the corn states not yet infested with the European corn borer.

The continuation of the projects now underway to introduce all effective parasites of the corn borer from Europe and Asia. The enlargement of these projects to include an intensive survey of the parasite possibilities throughout the known world distribution areas of the corn borer. These investigations should include a comprehensive study of the biology, host relationships, etc., of the introduced species after they become adapted to North American conditions.

The continuation of the studies relating to the biology and ecology of the corn borer under North American conditions with special emphasis upon the facts needed for the effective control of the species.

The continuation of biological investigations in the presumed native home of the insect (Europe) with especial emphasis upon the determination of ecological influences responsible for the development of areas of chronically severe, or chronically light infestation, or variable infestation as the case might be, together with the application of these findings to North American areas with the same or similar ecological environment. This involves a study of the influences responsible for one-generation or two-generation development, the status of parasites, variety of crops, damage, seasonal history, cultural methods, control methods, distribution and meteorological data, etc.

That we express our appreciation for the excellent progress that has been made in the development of machinery for cutting corn close to the ground, for ensilage cutting, and for shredding or otherwise handling corn in the field so as to destroy all the corn borers in the stalks and stubble after the corn is gathered. These investigations, together with the studies of attachments to plows that will facilitate the turning under of high stubble or standing corn stalks should be continued.

That the experiments to determine the value of plowing under corn debris as a means of destroying the corn borer larvae be continued. Such studies should include a determination of the comparative value of fall and spring plowing, of different dates and depths of plowing.

The continuation of the field surveys to determine the annual increase in dispersion and intensification of infestation.

Since the burning of the crop residues is an effective means of assisting in the control of the European corn borer, we recommend that further studies be carried on to determine the effect of the burning of corn residues on soil productivity.

That work upon insecticides and chemotaxy be resumed in the hope of finding methods by the use of which the individual grower can protect his crops.

That we recommend to those engaged in research along agronomic and animal nutrition lines that they study rotations with special reference to determining the degree to which it may be possible or desirable to substitute less susceptible crops for corn in those sections where the corn borer promises to become a serious pest.

That we suggest a thorough investigation of the possible further commercial utilization of corn residues.

That further attention be given in one-generation areas to weeds and other plants than corn to determine what part such plants may play in the future as breeding hosts

of the borer, especially in districts where, owing to the severity of the infestation, corn growing may be abandoned temporarily.

That we recommend to the extension service of the state and federal governments that they take every opportunity by demonstrations, exhibits and lectures to acquaint their constituencies with the gravity of the corn borer, the nature of the insect and its work, together with the methods of meeting with the situation. The need of the cooperation of every grower in the regions adjacent to the infested area as well as those within recognized corn borer territory should be emphasized.

That state and government publications be issued to keep the public fully informed regarding the development of the European corn borer situation. Annual mimeographed or printed reports of progress for distribution to interested workers also would be desirable.

That the committee act as a clearing house in advancing corn borer control measures by obtaining opinions from the entomologists and agronomists as to the lines of research and other methods which should be pursued, with special reference to needed investigations not now under way and which may have a practical application to the problem.

That the committee may be of service to the Secretary of the United States Department of Agriculture, the Canadian Minister of Agriculture, and other administrative officials, or to legislative bodies who are charged with making the final decisions in matters regarding appropriations and general policies affecting corn borer research and control by keeping them informed of the progress of the work and of field conditions, and by furnishing needed information relating to results of experiments and the requirements for continued work.

That we recommend that all states where European corn borer occurs, pass legislation at the next session of the legislature, authorizing the state department, in charge of operating quarantines, to stop and search vehicles and other carriers to ascertain if they are carrying corn or other produce that might be infested with the corn borer, and if contraband, to seize or prevent it from leaving the quarantined area. Also, that the states promulgate compulsory clean-up regulations that are adapted to their respective conditions in order to give greater assurance of the destruction of the corn borer.

It is recommended that copies of all written reports or recommendations of the committee be made available to the Secretary of the United States Department of Agriculture, and the Canadian Minister of Agriculture.

Respectfully submitted

Geo. A. Dean, L. E. Call
Lawson Caesar W. L. Burlison
J. J. Davis J. F. Cox
C. J. Drake R. M. Salter
D. J. Caffrey F. D. Richey

Joint committee of entomologists and agronomists.

Voted that the report be adopted.

President Arthur Gibson: The next is the report of the Committee on Insect Pest Survey.

REPORT OF THE COMMITTEE ON INSECT PEST SURVEY

The results achieved by the Insect Pest Survey at Washington and the Crop Pest Survey of the Dominion Entomological Branch of Canada have justified the undertaking and these agencies merit the hearty support of all members of this Association. We believe that these agencies should be provided with adequate facilities for extending the work generally throughout the territory, for increasing the number of collaborators and for keeping in personal contact with leaders in survey work throughout the country. Additional facilities should be provided for studying and digesting all data, both current and published, which may throw light on the problems connected with the distribution of insect pests. These agencies should be recognized as special activities with a definite field of effort peculiar to themselves. With more adequate support from our members as collaborators they can function more effectively in sending out information concerning the beginnings of insect outbreaks. Experimental work in the methods of estimating the abundance of insects should be encouraged.

As an aid to the early detection of imported pests we feel that the preparation of State and regional lists of insects should be encouraged. In this way the co-operation of great numbers of collaborators can be secured and many valuable data obtained at a minimum of expense.

(Signed) C. R. Crosby, *Chairman*
J. M. Swaine
R. W Harned
Committee

Voted that the report be adopted.

President Arthur Gibson: The next is the report of the Delegate to the Pan Pacific Congress.

(The report was received too late for reading at the meeting.)

REPORT OF THE DELEGATE TO THE PAN-PACIFIC CONGRESS

I beg to submit herewith a brief report of the session of the Third Pan-Pacific Congress at which I had the honour to represent as delegate, the American Association of Economic Entomologists.

The Congress was held in the General Hall of Tokyo Imperial University and in the Imperial Diet Building, in Tokyo, from October 30 to November 11, 1926. The Congress was attended by roughly speaking, six hundred delegates, of whom two hundred were overseas and the others local representatives.

The work of the Congress was separated into two Divisions, Physical Sciences and Biological Sciences. The latter being subdivided into the sections of Agriculture, Botany, Hygiene and Medicine, Zoology and Fisheries. Joint Divisional and Sectional meetings were held.

Papers on Entomology were chiefly economic in nature and were read in the section of Agriculture and pertained mainly to the subject of information regarding the insect fauna of the Pacific region, particularly insects affecting plants and animals of economic importance. There were no papers on pure Entomology.

An outstanding result of the congress from the standpoint of Economy was the resolution regarding Crop Protection. The Congress recommended and approved the appointment of an international Crop Protection Committee or board, to promote

and coordinate and investigate the crop enemies and related subjects throughout the Pacific region, and when necessary in other regions, such as the West Indies, which have close commercial relations with Pacific countries. It was suggested that a committee be designated to organize such work and provide for its support by the countries concerned, and for the selection of the said international Crop Protection Committee.

The following items were specified for the Committee:

(a) To promote surveys throughout the Pacific area for the purpose of acquiring information as promptly as possible concerning both the known and probable enemies of crops, and also concerning the parasites and other agencies which may be useful in the control of such crop enemies.

(b) To encourage research work necessary for the local control of such enemies, to determine what quarantine methods may be warranted, and to develop better methods of inspecting and disseminating plants and plant products.

(c) To promote the development by each country of larger numbers of trained workers in the general field of Plant Pest Survey and Control.

(d) To obtain agreements and understandings between countries as to giving prompt notification of the appearance of any new and destructive pests, and to secure the cooperation of such countries in the prevention of the spread of such pests.

Among the more important papers read at the Congress were:

S. Matsumura:	"Important Insect Fauna of Japan."
	"Insect Fauna of the Pacific Region."
G. Okajima:	"On the Distribution of the Injurious Insects of the Rice Plant in Japan with Reference to their Extent among the Adjacent Territories of the Orient."
S. Kinoshita:	"On the Biology and Control of Cutworms."
W. E. Hoffmann:	"Some Insect Pests of the Families Pentatomidae and Coreidae."
O. Shinji:	"Aphids found in Japan Proper."
L. B. Uichanco:	"Insects in Relation to the Introduced Cultivated Element of the Philippine Flora."
G. H. Corbett:	"Insects on Coconuts in Malaya."
B. A. R. Gater:	"The Malayan Coconut Zygaenid and its Relation to *Leouana iridescens* in Fiji."
D. T. Fullaway:	"*Adoretus sinensis* and its Natural Enemies in the Orient."
I. Kuwana:	"Aleyrodidae or White Flies Attacking Citrus Plants in Japan."

Papers in regard to Plant Quarantine were read and discussed at the Divisional meetings of Biological Science. The following were among the more important papers:

D. T. Fullaway:	"Some Practical Considerations in Plant Quarantine."
W. T, Swingle:	"Safeguarding the Introduction of Plants from Foreign Countries or Distant Regions by Aseptic Propagation in Pest-free Greenhouses."
I. Kuwana:	"The Scientific Basis for Plant Quarantine in the Countries of the Pacific."

S. Matsumura:	"Plant Quarantine."
C. Harukawa:	"The Scientific Basis of Plant Quarantine in the Countries of the Pacific."
H. Yuasa:	"On the Advantages of the X-ray Examination of Certain Classes of Materials and Insects Subject to Plant Quarantine Regulations."

Following is a summary of the number and nationality of overseas delegates and visitors to the Congress:—

U. S., 62, Australia 29, Canada 8, Chile 1, China 11; France 8, England 4, Hawaii 11, Hongkong 1, Netherlands 3, East Indies 12, New Zealand 6, Malay 5, Papua 1, Peru 1, Philippines 11, Portugal 1. Total 187.

Local delegates, approximately 400.

Yours very truly,
S. I. KUWANA.

PRESIDENT ARTHUR GIBSON: The next item on the program is the appointment of committees. Your Chairman has pleasure in appointing the following committees:

Committee on Nominations: J. A. Hyslop, Chairman, C. H. Kennedy and R. W. Leiby.

Committee on Resolutions: R. C. Osburn, Chairman, Alvah Peterson and L. S. McLaine.

Committee on Membership (owing to the absence of one member of the committee): Z. P. Metcalf, pro tem.

Is there any miscellaneous business to come before the meeting? Any new business? If not, I shall ask Vice-President Drake to take the Chair.

FINAL BUSINESS

The final business was transacted Saturday morning, January 1, 1927.

PRESIDENT ARTHUR GIBSON: The first item of business is the report of the Committee on Resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS

RESOLVED THAT:

I. We express our appreciation and thanks to the Local committees for the very excellent facilities afforded and entertainments provided for the members of this Association at the Philadelphia meeting.

II. We express our thanks to the authorities of the University of Pennsylvania for their kindness in placing at the disposal of this Association such excellent accommodations for the meetings.

III. The members of this Association at their Philadelphia meeting express their deep regret on learning of the illness of Professor J. H. Comstock.

IV. The special committee appointed by the President to investigate arsenical residues be made a standing committee.

V. The special committee appointed to cooperate with the American Society of Agronomy to investigate European Corn Borer control be made a standing committee.

VI. The President appoint a delegate to attend the meetings of the Cotton States Entomologists, the Southern Branch of this Association, which are to be held on February 2, 3 and 4, 1927.

VII. The reports of the standing and special committees be presented to the Secretary of this Association and that only summaries of the reports in question be presented orally at the regular meetings of the Association.

VIII. The Program Committee at the next meeting of this Association, provide for at least one symposium; consider the advisability of requesting members to present only a summary of their papers at the sessions, and arrange for a special session for teachers in entomology to consider teaching methods.

IX. WHEREAS, several special meetings and conferences have been called informally, interfering to some extent with our regular program; *Resolved*, That any individuals or groups desiring to call special meetings or conferences in connection with future meetings, be requested to confer with the Secretary of this Association before arranging for them.

(Signed) ALVAH PETERSON
L. S. MCLAINE
R. C. OSBURN, *Chairman*

It was voted that the first six resolutions be adopted.

There was some discussion on Resolution 5 before Resolutions 1 to 6 were adopted. The question was raised as to the wish of the Association whether the Corn Borer Committee was to carry over another year or was the present committee discharged. No action was taken at the first reading of the resolutions committee report. President-Elect Harned, however, ruled that that committee will stand until a new committee is selected and it was voted that the committee as it now exists be accepted as a standing committee.

Resolution 7 was re-read and discussed, It was voted that this resolution be adopted with the understanding that the chairman of the various committees give the oral report before the Association.

Resolution 8 was read and explained by R. C. Osburn as follows:

MR. R. C. OSBURN: I think in part this was meant to shorten our program in the presentation of papers and also as suggestions for the Program Committee in regard to these two items. A symposium has been desired by many, also this special session on the discussion of teaching methods in entomology. To give room for two such discussions as those, it would probably be necessary to shorten the presentation of the papers.

Voted that Resolution 8 be adopted.

Resolution 9 was read and explained by R. C. Osburn as follows:

Mr. R. C. Osburn: I think that is only just. If such meetings can be arranged in conference with the Secretary or the officers of the Association, it will avoid any confusion whatsoever. It won't break up work, then, that is regularly arranged for. No doubt such "side shows" could readily be provided for and time found for them without much interference if the Secretary, who has the program in hand, could be consulted.

Voted that resolution 9 be adopted.

It was then voted that the whole report be adopted.

President Arthur Gibson: Next is the report of the Committee on Membership.

REPORT OF COMMITTEE ON MEMBERSHIP

The committee on membership submits the following report:

1. It recommends for election to associate membership the following 88 persons:

McGinnis, G. R.
Lawson, Paul B.
Abercrombie, H. T.
Arnold, R. B.
Baldwin, R. S.
Grady, H. J.
Grossman, E. R.
Hawkins, J. H.
Atkinson, N. J.
Davis, E. G.
Richardson, H. H.
Dirks, C. O.
Polioka, J. B.
Haegele, T. W.
Campbell, C. F.
Haeussler, G. J.
Daviault, Lionel
Pope, J. B.
Powell, Adinor R.
Marshall, James
Nelson, F. C.
Osterberger, B. A.
Craig, F. W.
Williams, V. E.
Nikolsky, V. V.
Boyce, A. M.
Walsh, S. G.
Borden, A. D.
Griffin, E. L.
Lipp, J. W.
Sherman, Franklin III
Hervey, G. E. R.
Hambleton, E. J.
Garthside, S.
Blisard, T. J.
Chapman, W. W.
Grant, D. H.
Stone, M. W.
McPhail, M.
Dibble, C. B.
Arbuthnot, Kenneth D.
Tolles, G. S.
Proper, A. B.
Christenson, L. D.
Ross, T. S.
O'Dell, J. H.
DeCoursey, R. M.
Reynolds, G. D.
Farrar, C. L.
Sorenson, C. J.
Winter, J. D.
Dove, W. H.
Filinger, G. A.
Roark, R. C.
Worthington, G. V.
Spruijt, F. J.
Pillsbury, A. E.
Drinnan, Dana E.
Wheeler, C. M.
Bailey, J. B.
Brunson, M. H.
Roney, J. H.
Harrison, P. K.
Bottel, A. E.
Tubbs, D. W.
Turner, C. K.
Robinson, Sid
Cooley, C. E.
Dills, L. E.
Lee, J. E.
Dixon, J. W.
Kingwill, H. M.
Kellogg, E. S.
Berryhill, I. W.
Fulton, G. R.
Cockerham, K. L.
Deen, O. T.
Amsler, Fred P.
Steiner, Loren F.
Ginsburg, J. M.
Fagan, J. F.
Miller, P. H.
Poe, S. E.
McDowell, O. S.
Spangenberg, H.
Collier, R. O.
Steenburgh, W. E.
Holdaway, F. G.

2. The committee recommends that the following 35 associate members be transferred to active membership:

Readio, P. A.	Sanders, P. D.	Hoffman, W. A.
Strand, A. L.	Beckwith, C. S.	Jewett, H. H.
Thompson, B. G.	Bedford, Theo.	Kinsey, A. C.
Neiswander, C. R.	Brannon, C. H.	Mitchell, T. B.
Vorhies, C. T.	Brimley, C. S.	Rea, G. H.
Smith, M. R.	Butcher, Fred D.	Ryan, H. J.
Alden, C. H.	Coe, Wesley	Sechrist, E. L.
Bailey, H. L.	Eckert, J. E.	Spuler, Anthony
Kirk, H. B.	English, L. L.	Underhill, G. W.
Batchelder, C. H.	Fisher, W. S.	Whitcomb, W. D.
Eyer, J. R.	Folsom, J. W.	Worthley, H. N.
Trimble, F. M.	Hargraves, E.	

3. The committee recommends that the following persons be re-instated in the Association:

Barnes, P. T. Wallace, F. N.

4. The committee recommends that the resignations of the following members be accepted:

Active	Associate	Craighead, E. M.
O'Byrne, F M.	Bynum, E K.	Oertel, Everett
Rogers, D. M.		

Respectfully submitted,
W. P. Flint, *Chairman*
J. A. Hyslop
Z. P. Metcalf, (Pro tem)
Committee

Voted that the report be adopted.

President Arthur Gibson: The next is the nomination of Journal officers by Advisory Committee.

NOMINATIONS OF JOURNAL OFFICERS BY ADVISORY COMMITTEE

Editor—E. P. Felt
Associate Editor—W. E. Britton
Business Manager—C. W. Collins

(Signed) E. N. Cory
Franklin Sherman
For the Committee

Voted that the report be adopted.

President Arthur Gibson: The next item of business is the report of the Committee on Nominations.

REPORT OF COMMITTEE ON NOMINATIONS

President, R. W. Harned, A. & M. College, Miss.
First Vice-President, W. P. Flint, Urbana, Ill.

Second Vice-President, (Pacific Slope Branch), R. W. Doane, Stanford University, Calif.

Third Vice-President (Cotton States Branch), Franklin Sherman, Clemson College, S. C.

Fourth Vice-President (Section of Plant Quarantine and Inspection), J. H. Montgomery, Gainesville, Florida.

Fifth Vice-President (Section of Apiculture), F. E. Millen, Guelph, Ont. Canada.

Secretary, C. W. Collins, Melrose Highlands, Mass. Term expires 1929.

STANDING COMMITTEES

Policy:	Arthur Gibson, Ottawa, Ont. Canada. Term expires 1931.
Trustees for Permanent Fund:	G. M. Bentley, Knoxville, Tenn. Term expires 1929.
	E. N. Cory, College Park, Md. Term expires 1928.
	T. J. Headlee, New Brunswick, N. J. Term expires 1927.
Nomenclature:	E. O. Essig, Berkeley, Calif.
	F. C. Bishopp, Dallas, Texas.
	H. B. Hungerford, Lawrence, Kansas.
	H. G. Crawford, Ottawa, Ont., Canada.
	J. A. Hyslop, Washington, D. C.
Membership:	D. M. DeLong, Columbus, Ohio. Term expires 1929.
Advisory Board Journal of Economic Entomology:	J. W. McColloch, Manhattan, Kans. Term expires 1929.
	J. M. Swaine, Ottawa, Ont., Canada. Term expires 1929.
U. S. National Museum:	E. C. Van Dyke, Berkeley, Calif.
Representative to National Research Council:	W. A. Riley, St. Paul, Minn. Term expires 1929.
Councillors to American Association for the Advancement of Science:	G. A. Dean, Manhattan, Kansas.
	G. W. Herrick, Ithaca, N. Y.
Trustee for Crop Protection Institute:	W. C. O'Kane, Durham, N. H. Term expires 1929.
Representatives on Council of Union of American Biological Societies:	A. L. Quaintance, Washington, D. C.
	C. R. Crosby, Ithaca, N. Y.
Representative on Board of Trustees of Tropical Plant Research Foundation:	Herbert Osborn, Columbus, Ohio.

J. A. HYSLOP
R. W. LEIBY
C. H. KENNEDY, *Committee*

Voted that the report be adopted and the Secretary be instructed to cast the unanimous ballot for the Association.

PRESIDENT ARTHUR GIBSON: Will Past President Ball and Past President Dean kindly escort President-Elect Harned to the Chair?

(Past President Ball and Past President Dean escorted President-Elect Harned to the Chair.)

PRESIDENT GIBSON: I take very great pleasure in turning over to you the affairs of the Association for the year 1927. I hope you will have as much pleasure in conducting the affairs of this Association in 1927 as I have had during 1926. (Applause.)

PRESIDENT-ELECT HARNED: I believe it is customary for the man who has been so highly honored to try to make a few remarks. I am simply incapable of doing that on this occasion. I know that no one has ever been so honored who deserves it less. I am sure I have never done anything to deserve this high honor, but I hope it will always make me try to do more and that I shall never do anything that will cause the Association to regret their action in this matter.

I don't want you to think that I am unappreciative or ungrateful because I feel incapable of making any further remarks at this time. (Applause.)

The next item is miscellaneous business.

MR. E. O. ESSIG: There is one, relative to a card index and extract of literature pertaining to insecticides which I was asked to present at this meeting.

Some time ago, Mr. E. R. deOng, who was particularly interested in insecticides, attempted in his own work to get together a card index of all literature relative to insecticides. He proposed not only an index but perhaps also an abstract of this literature. He corresponded quite extensively with certain members of this Association, and particularly with Past President Gibson. Mr. Gibson presented that literature to me, which I summarized as follows:

He suggested the following means for obtaining this index: Either by subscription, for which procedure he estimated $1200 would be necessary, or by actually sponsoring certain groups in the insecticide field, such as arsenic, sulphur, oil, cyanide, soaps, and so on. He had divided this into fifteen different groups.

I understand that some progress has been made in the past. What has been accomplished may be summarized as follows: Four private subscribers on the Pacific Coast have already said they would give $400 to this work. An index of sulphur has been started and is well under way, as is also an index of oils. A great deal of correspondence has been done

between Mr. deOng and Mr. Gibson and other members of the Association.

There are some suggestions which might be thrown out: That this might be undertaken through private subscriptions or by cooperative agencies, such as private spray manufacturers, state experiment stations, federal agencies, etc. A suggestion was made that it might be referred to the International Institute of Rome.

The suggestion which I wish to make at this time, in order to get this matter before the house, is that it be referred to the Executive Committee of the American Association of Economic Entomologists, and for them in turn to refer it to the Editorial Board or to the Committee on Policy as they may see fit.

Mr. E. D. Ball: If that is a motion, I will second it.

Mr. H. J. Quayle: Isn't that subject going to be covered by the Insecticide and Fungicide Laboratory?

Mr. Roark has already prepared one on chloropicrin, and I understand from him it is a very valuable paper. I understand Mr. Roark is going to prepare others on various insecticides and fungicides.

Mr. E. O. Essig: I might say in that connection it is my understanding that Mr. deOng did get in touch with the Bureau of Entomology and such others as he could. Personally I know of no other way of handling this unless it be sponsored by some definite agency such as has been proposed. That is the reason for proposing this.

The motion was carried.

President-Elect R. W. Harned: The next thing is fixing the time and place of the next meeting.

Secretary C. W. Collins: Mr. Chairman, I move the next meeting be held at the same time and place as that of the American Association for the Advancement of Science, namely, Nashville, Tennessee.

The motion was carried.

Mr. R. W. Doane: The West Coast Branch of this Association is to meet in Reno, Nevada. We should like to see a goodly number of the eastern members of this Association at that meeting. If you do not care to stay long enough to establish your residence there, you may come on out to California and see the conditions out there. We extend to you a very hearty invitation to attend that meeting.

President-Elect R. W. Harned: The next meeting will be held in Nashville in the south, and I hope everyone here will be there and that you will bring many more with you, and do everything possible to make it half as good as this meeting. If it is, I am sure it will be a big success.

Mr. Arthur Gibson: I move we adjourn.

The motion was carried.

Adjournment: 11:25 a. m.

PART II. ADDRESSES, PAPERS, AND DISCUSSIONS

The address of the President was delivered at the close of the morning session, Wednesday, December 29, Vice-President C. J. Drake in the chair.

VICE-PRESIDENT C. J. DRAKE: Next on the program is the Annual Address of the President, Mr. Arthur Gibson.

INTERNATIONAL ENTOMOLOGY — RETROSPECTIVE AND PROSPECTIVE

By ARTHUR GIBSON, *Dominion Entomologist, Ottawa, Canada*

ABSTRACT

Some of the developments, particularly during the last decade, which have assisted in bringing about a closer spirit of co-operation in entomological problems international in nature are discussed in the first half of the address. In the latter half—Prospective—the importance of future developments relating to the biological control of insects, national collections of insects, interchange of workers, etc., are emphasized.

Entomology in North America recognizes no national barriers. There are no warning posters along the international boundary between Canada and the United States reading "Keep out—no foreign entomologists admitted." For considerably over one hundred years friendly relations have existed between the two countries and no natural science disputes serious in nature have developed. The science of economic entomology has, indeed, been fortunate in having leaders of broad thought and outlook, and to such leaders we all owe very much, more indeed than any of us can ever repay. Two men especially always stand out prominently in my memory. One of these has long since departed this life, having passed to the great beyond in the year 1908. He was a prince among men—big of heart, broad of mind, wonderfully kind to everyone, passionately fond of the truth, noble in thought and deed, and withal an entomologist of whom Canada has always been proud, one to whom we owe much by reason of the firm foundation he so ably assisted in building and upon which a structure has been erected, the value of which I think is being more and more appreciated as the years roll on. This Association in the early years of its existence was much strengthened by the service he rendered, which service has been acknowledged by others on previous occasions. I refer to the late James Fletcher known and loved by many of the older members here today. It was my great privilege to have had him as my chief for a period of ten years. What this has meant to me can only be appreciated by others who also had the pleasure and help of his comradeship. I realize only too well that had it

not been for the association with and the training I had under Fletcher, I surely would not to-day have the honour of being President of the American Association of Economic Entomologists.

The other man is L. O. Howard whom I first met about twenty-five years ago. No one could have been kinder to me on that occasion. During the years that have followed, he has always shown a most sympathetic interest in our work and has continued to assist us in every way he could. It is unnecessary to comment on the remarkable organization which Dr. Howard and his associates have built up or to the important contributions with which he personally has enriched our literature. All of this is well known to our members.

INTERNATIONAL ENTOMOLOGY—The title of my address—so far at least as Canada and the United States is concerned, had, in my opinion, its real inception with Fletcher and Howard, who were close personal friends.

RETROSPECTIVE

In Fletcher's report as Dominion Entomologist for 1885, we read: "From the geographical position of Canada and the United States, many of our interests and theirs are naturally identical . . . Year after year fresh States of the great republic, whose boundaries touch our own for more than 3000 miles, are added to those who acknowledge the necessity of having a government official who shall devote all his time to studying the habits of insects injurious to agriculture and the methods for controlling and preventing their depredations." In his report for 1899 there is a reproduction from a photograph, showing Fletcher, Lugger and McKellar, searching for grasshopper eggs in Manitoba—a joint investigation made at the request of the Hon. Thomas Greenway, then Premier of Manitoba. In the 29th Annual Report of the Entomological Society of Ontario (1898), there is a very interesting and suggestive paper by the late Prof. F. M. Webster, entitled "Some Economic Features of International Entomology." One of the closing sentences therein reads as follows: "In all of these matters Canada and the United States are one, and this being true, there must be no lines of separation between the entomologists of these two countries. We must work together, shoulder to shoulder, and God speed the day when we shall do this, to even a greater degree than we are now doing."

Now for a few minutes, having in mind the United States and Canada, let us see what actually has developed in bringing about a closer spirit of co-operation in entomological problems international in nature. What are some of the developments, by way of illustration, and without

going back too far, which have taken place say during the last decade?

SPREAD OF GYPSY MOTH PARASITES.—Through the kind co-operation of the United States Bureau of Entomology, officers of the Canadian Entomological Service have been stationed from time to time at the Gypsy Moth Parasite Laboratory, Melrose Highlands, Mass., for the purpose of rearing and forwarding to Canada, useful parasites of the Gypsy Moth, as well as of the Brown-tail Moth. Thousands of specimens of *Apanteles lactiecolor* and *Compsilura concinnata* were thus introduced into Eastern Canada, and have, during recent years, been recovered at several rather widely separated points. In addition, over four thousand specimens of the *Calosoma sycophanta* were introduced.

EUROPEAN CORN BORER—Previous to the finding of the European corn borer in Canada, employees of the Dominion Federal service were allowed to visit the United States to become familiar with the work of the insect and thus develop into capable scouts. Since the discovery of the borer in the province of Ontario in 1920, United States and Canadian Entomologists have had many joint conferences on both sides of the international line.

Ever since the borer was found in North America, federal, state and provincial officers have co-operated closely in all phases of research and quarantine work with the result that there has developed a bond of fellowship, official and personal, an excellent example in fact of international co-operation.

GRASSHOPPER INVESTIGATIONS.—During the recent outbreak of grasshoppers in western Canada, there has been excellent co-operation between the entomologists of Canada and the United States. Joint meetings have been held on both sides of the boundary line which have undoubtedly been of great value to both countries. In this way information regarding the spread of important species was obtained which has assisted materially in outlining and developing future work.

OTHER BIOLOGICAL INVESTIGATIONS.—Much could also be said of the close co-operation which has been developed in connection with investigations relating to the bionomics of white grubs, the Hessian fly, grass-infesting oscinids, certain forest and other insects. All of these investigations participated in by United States and Canadian entomologists are indeed worthy of the highest commendation.

NATIONAL COLLECTIONS OF INSECTS.—During recent years there has been an increasing number of visits of United States entomologists to Ottawa to study material in the Canadian National Collection, and correspondingly more visits by Canadians have of late been made to Washington to examine types and other specimens in the United States

National Museum. Workers in both countries have thus been brought closer and closer together with the result that the two national collections of insects in North America have been enriched by additions of material of great value.

THE NORTHWEST INTERNATIONAL COMMITTEE ON FARM PESTS.—This Committee was organized at a gathering of United States and Canadian entomologists held in Winnipeg, Man., in 1920. The objects at that time were to promote a closer co-operation in grasshopper control, but later it was broadened to include all insects that threatened the crops on either side of the international boundary. The idea, primarily, was to take joint action in controlling pests which might with neglect spread from one part of the country to another. The International Committee on Farm Pests guarded against this by providing that the officials of the territory involved would make every effort to control any important pest that developed, and in addition to such direct action, it was agreed to keep each member informed of impending outbreaks in any particular area and to exchange, freely, information regarding results obtained in control studies incepted. Through this latter arrangement alone, much advanced information has been made available which has had a direct bearing on insect control. Uniform experiments, too, are undertaken by members in the different bordering states and provinces, the results of which are recorded and compared at the annual meetings. Meetings to date have been held at Winnipeg, Man.; Regina, Sask.; Minot, N. D.; Bozeman, Mont.; St. Paul, Minn.; and Lethbridge, Alta. The meetings are quite informal—there are no set papers and no fees. There is no question but that these meetings have been both a direct and indirect means of preventing loss to crops from insect pests, particularly in the case of grasshoppers and cutworms. Their influences in promoting co-operation and good fellowship have been very great.

INSECT PEST SURVEYS.—Since the spring of 1923, the Entomological Services of the United States and Canada have co-operated in presenting to the entomological workers of both countries a monthly summary of current insect conditions throughout their respective territories through the medium of the United States Insect Pest Survey Bulletin and the Canadian Insect Pest Review. These two manuscript publications were brought into being to fulfill the need of a medium whereby current entomological data could be assembled and correlated, and made immediately available to investigators in the field.

The need for insect pest survey work was first recognized and acted upon in the United States, the Bureau of Entomology organizing an Insect Pest Survey in 1921 under the immediate direction of Mr. J. A.

Hyslop. In Canada, in the autumn of 1922, the late Mr. R. C. Treherne, was largely instrumental in establishing an insect pest survey along similar lines and with similar aims to that in the United States.

The exchange of monthly summaries of insect conditions in the United States and Canada is undoubtedly of great value in that they assist entomologists in both countries to form more accurate estimates of the extent and intensity of insect outbreaks. They indicate, too, the presence of incipient outbreaks; give warning of the distribution and spread of injurious species, and record the introduction of new undesirable pests, thus enabling efficient precautionary measures to be taken before the latter are too firmly established.

THE WESTERN PLANT QUARANTINE BOARD.—This organization composed of representatives from the western states, Lower California, Hawaii and British Columbia was incepted in 1919. Meetings are held annually for the purpose of unifying insect and pest legislation in the various states, the reporting of new and serious pests, the consideration of matters of general interest, etc. This Board has accomplished much useful work of an international character.

Let us now go further afield. What has been done in countries overseas to further international entomology? It would take many pages to answer this question fully but if we confine our remarks to comparatively recent years, we will see something of the trend of effort in this connection.

ORGANIZATIONS THAT HAVE ASSISTED.—In Europe, one of the most important agricultural organizations is the International Institute of Agriculture with headquarters at Rome. This Institute was established under the International treaty of June 7th, 1905, which was ratified by 40 governments. Thirty-three other governments have since adhered to the Institute.

So far as entomology is concerned the Institute has taken a deep interest in the development of entomological services in the adhering governments, and in all legislation which in any way affects the movements of plant products and the possible spread of noxious insects thereby. The "Monthly Bulletin of Agricultural Intelligence and Plant Diseases" established in 1909 was continued until 1922, when it was decided to issue a new journal to appear quarterly and known as "International Review of the Science and Practice of Agriculture." In both of these publications brief summaries are given of entomological publications, issued in various countries, and original articles as well, also appear from time to time. In addition to the journals mentioned,

a number of separate monographs have been issued. Those of interest to entomologists are: "The Present Organization of the Services for the Control of Plant Diseases (which of course includes insects) in Different Countries," published in 1914; "The Control Measures Against Locusts in Different Countries," published in 1916; and "The Measures Against the Olive Fly in Different Countries," published in 1922.

At a meeting of the general assembly of the Institute held in April, 1926, it was decided to issue a separate monthly bulletin, on plant diseases and pests, the first issue to appear in January, 1927. Chapter I of the proposed publication, which will it is expected have collaborators in all adhering countries, will relate to discoveries and current events in world entomology and plant pathology; Chapter II, to various questions relating to plant protection in the different countries; Chapter III, to Legislative and Administrative Measures for plant protection; Chapter IV to a bibliography relating to plant diseases and pests, and Chapter V to current notes.

The Imperial Bureau of Entomology, established in 1913, has aided world entomology to a very important extent. Such publications as the "Review of Applied Entomology" and the "Zoological Record" are obviously of international significance. As opportunity offered the Bureau has distributed named sets of insects to institutions in many parts of the world, especially to places where they would be of use in teaching medical entomology. The identification work of the Bureau has always been based on an international outlook and in the past much material has been named for the Dutch Colonies, various South American States, and other countries. Although the Bureau serves as an entomological clearing house for the Colonies and Dominions of the Empire, at the same time, its officers are always ready to render assistance to entomologists of any country.

Conferences in London such as that which took place in 1925, and which I had the pleasure of reporting upon at the Kansas City meeting, are considered desirable at five year periods.

INTERNATIONAL CONGRESSES AND WORLD CONFERENCES.—Since the First International Congress of Entomology held in Brussels in 1910, there have been two further similar congresses, namely at Oxford in 1912 and at Zurich in 1925. All of these conferences were highly successful, bringing together as they did entomologists from the various countries of the world. An important conference too, of plant pathologists and entomologists was held in Holland in 1923. There is no doubt, whatever, that these international gatherings are of great value. They certainly

are the means of establishing important personal relationships and undoubtedly make for better international co-operation.

It has been my privilege to attend two international conferences in Europe and to note the high favour in which our Association is held. The Association although called the American Association of Economic Entomologists, may well be considered international in character. While we include practically all workers in applied entomology in North America, at the same time we have a rather imposing list of foreign members. This foreign list it seems to me could be added to very materially, and I would suggest to our Membership Committee that an effort in this direction be made.

It is of special interest to note that H. R. H. The Prince of Wales in his Presidential Address delivered to the British Association for the Advancement of Science, at Oxford, on August 4th, 1926, referring to the trend of scientific developments said "Nothing but good can follow from personal contact, between scientific workers in different parts of the Empire. Nothing but good can follow from their researches if they add, as gradually they must add, to the wider knowledge of the Empire, not only among the workers themselves, but ultimately among the whole body of informed Imperial citizenship." Referring to meetings of the Association held overseas, he said: "Those of our members who travelled from Great Britain to take part in these meetings have had peculiar opportunities to meet and discuss each his own scientific problems with fellow workers in the Dominions—and it should be added with particular reference to those meetings which have been held in Canada that they have provided almost unique opportunities for personal contact between British workers in science and their American colleagues."

This Association adopted a resolution at the Kansas City meeting, favouring the holding of the Fourth International Congress of Entomologists in America in 1928, and your President, as stated in the report of the Executive Committee appointed a committee to consider possible arrangements.

Prospective

I now come to the difficult part of my address. In these days of intense activity, one is being continually amazed as a result of the advances accomplished in the various sciences. In few fields of research have greater advances been made during recent years than in applied entomology.

You are all familiar with the developments in the use of the airplane for scouting purposes and the application of insecticides; the remarkable progress in the discovery of new and cheaper poisons for insect control;

the application of ecology to insect study; the increased interest in natural control projects, and so on. The future will undoubtedly reveal still more wonderful achievements in the various countries of the world where the entomologist is at work. The entomologist of today hides nothing from his fellow worker; to the stranger too, he delights in the giving of knowledge gained from his researches. In my official travels, particularly during recent years I have had plenty of evidence of this fact. Members of this Association, resident as they are throughout the world, have indeed rendered valuable assistance in developing a bond of good fellowship, the results of which will be even more apparent in the future than they have been in the past.

INTERNATIONAL CO-OPERATION.— It is, of course, to be regretted, that destructive forms of insects take on the bad habit of spreading and thus are no respecters of human property, even that of a neighbouring nation. There are striking records of such migration or introductions, for instance in the case of the Colorado potato beetle, the San Jose scale, the Gypsy moth, the European corn borer, and the Japanese beetle.

In matters looking to the control of a widespread insect, particularly one which has assumed international importance, every co-operative effort which gives promise of assistance should be brought into service. In the years to come this spirit of international co-operation will undoubtedly develop more rapidly and become greatly strengthened by the work of members of this Association. The corn borer conference held in September last at Chatham, Ont., and Detroit, Mich., illustrated a most interesting and valuable advance in international co-operation between the entomologist, the agronomist, the agricultural engineer, and the animal husbandman. At no previous time in the history of applied entomology, has there been such a joint effort to devise ways and means of defeating an insect which has developed into an extremely important international menace. At the final session held in Detroit, at which there were present close to two hundred representatives of various institutions and organizations, a committee was named and approved in conference to assist in the formulation of plans and policies relating to corn borer control.

During the last decade, there has been a marked development in applied entomology in Canada and as a consequence there will be many more opportunities in the future for close co-operation between the workers of the two English-speaking nations of North America.

As regards other nations, this Association can do much to develop a better co-operation between workers in entomology throughout the world. Certain of our members visit from time to time sections of

Europe and other continents and in their association with the resident entomologists have opportunity to discuss problems of one kind or other, which would undoubtedly be solved much more quickly with co-operative effort.

During my term of office, two important committees in addition to the corn borer committee were appointed to deal with matters of international significance, namely insect pest surveys, and arsenical residues on fruits.

THE BIOLOGICAL CONTROL OF INSECTS.—This most fascinating field of endeavour has undoubtedly a most useful future. In almost every country where a broad entomological service is being developed, workers are showing an increased interest in studies relating to the biological control of insects. When Dr. R. J. Tillyard of New Zealand discussed this subject at the First Imperial Entomological Conference, held in London, England, in 1920, there were, in his own words, "more speakers opposed to this method than in favour of it, and the great majority were in a position of doubt, not knowing what to think about it." Since that year, there has, however, been a decided change of opinion, generally. so far as Imperial entomologists are concerned. At the conference held in London in 1925, in fact, it was decided to accept the principle that the Imperial Bureau of Entomology should arrange for the export to Overseas Governments of beneficial parasites. Since, it is of interest to note that the recently constituted Empire Marketing Board had approved of grants to the Imperial Bureau of Entomology, namely a capital grant of £15,000 and annual grants of £4,000 for a period of five years—these grants to be used mainly for parasite investigations.

In no country of the world has the biological control of insects been under investigation to such an extent as in the United States, and the great leader, in all of this work has been our valued member and counsellor, Dr. L. O. Howard.

Officers of the United States Bureau of Entomology, as you know, are searching in a number of foreign countries for parasites of destructive insects which have gained a foothold in the United States. At the Kansas City meeting of this Association a resolution, was approved, "urging the establishment by the United States Bureau of Entomology of foreign field stations wherever advisable for the study of problems pertaining to insects already introduced or likely to be introduced into this country." A similar resolution was adopted by the Entomological Society of America.

It is not necessary that I should impress upon the members of this Association the value of studies relating to the biological control of

insects. There are, as we all know, a number of very striking instances of success having been obtained in introducing parasitic or other beneficial insects into a country where the host insect had become established and was causing important damage to crops. The entomologists in the Hawaiian Islands, for instance, have had much success in this form of control. At the Pan-Pacific Food Conservation Conference held in Honolulu in 1924, a resolution was passed urging that governments and institutions facilitate the international exchange of parasites in every possible manner and afford to experts of other countries engaged in exploration work of this character all possible assistance.

So far as Canada is concerned the following remarks regarding recent work may be of interest.

In the year 1913 the late Dr. C. Gordon Hewitt, arranged for a shipment of cocoons of the larch sawfly, parasitized by *Mesolieus tenthredinis* to be sent to Canada. The material was received in excellent condition and the parasites were duly liberated in the province of Manitoba where the larch sawfly was abundant. Recoveries of the parasite have been made on several occasions since 1913 but it was not until 1918 that observations indicated a noticeable increase in the numbers of the parasite particularly in an isolated larch swamp eight miles distant from the original place of introduction. Numbers of overwintering cocoons of 1925-1926 were examined and found to be parasitized to the extent of 64 per cent.

In August, 1925, I had a request from Dr. R. J. Tillyard, of New Zealand, for living specimens of Canadian chrysopids to help in checking the ravages of species of *Myzus* and *Myzocallis* on oak trees. On receipt of this communication I requested our officers in British Columbia to make a search for hibernating chrysopids and as a result 1900 specimens were despatched to New Zealand. In reporting upon the arrival of the specimens, Dr. Tillyard said "You will be glad to know that the consignment was highly successful, less than 50 being dead on arrival in Nelson. Of many previous consignments received during the past five years from many parts of the world, we have never succeeded in landing a single live lacewing into New Zealand. This makes the present achievement a most remarkable one and unless the species sent refuses to feed on the aphids we have in New Zealand, the introduction should be a complete success." A report received in March last indicated that a considerable number of eggs had been laid and that the larvae which hatched from them were feeding vigorously on various species of aphids. A later report issued in October stated: "Three generations have already been reared and a fair number have managed to survive the rather too

warm winter of Nelson." At the present time there is enroute to New Zealand a further large shipment of over 5000 specimens of chrysopids.

More recently, at the request of Mr. David Miller, Government Entomologist, New Zealand, I arranged for the forwarding of two shipments of white grubs parasitized by the tachinid, *Microphthalma michiganensis* Towns. The first consignment comprised 1060 tins, the second 500 tins, each containing, in earth, one parasitized grub. The grubs were collected in the neighbourhood of Hemmingford, Que. It is the hope that these parasitized grubs will produce adult flies in New Zealand which when liberated will take kindly to species of chafers of the genus *Odontria*.

As regards parasites of the European corn borer, owing to the very generous assistance of the United States Bureau of Entomology, the Canadian Entomological Service, has developed at Chatham, Ont., an important laboratory at which the European parasites *Habrobracon brevicornis* and *Exoristes roborator* have been reared and liberated in considerable numbers in the province of Ontario, 2,500,000 individuals of the former species, and 120,000 of the latter. Further co-operative work with other European parasites of the borer is in progress.

Plant Inspection. Applied entomologists generally are interested in the future of plant inspection work, the object of which is to prevent the export or import of insects. The responsibility resting upon the shoulders of those who actually do the inspection is very great indeed, and it seems to me in view of the important sums spent in such preventive work and its recognized necessity, the various countries of the world should strive to strengthen inspection services as much as possible and attract thereto a higher type of trained men.

The fact that insects may, through the various agencies of commerce, be transported from one country to another has done much to bring together experts of various countries with the undoubted result that plant inspection services have been better organized and understood generally and are now rendering more efficient service. In all of this development, world entomology, I think, has been helped in no small degree.

At various international conferences during comparatively recent years, discussions have taken place regarding the advisability of appointing international committees to consider matters relating to plant inspection work. So far as I know no definite action has as yet been taken in this regard. It seems only possible to expect that countries situated for instance as are the United States and Canada, could only agree in most general terms to any international insect legislation.

The needs and risks of the various countries of the world are so diverse. Following a study of the Rome convention, a sub-committee, appointed at the Imperial Entomological Conference of 1920 reported that "it is impracticable to frame any such convention to which all countries may be expected to subscribe and which at the same time would have material value." An international committee, however, I think could be highly useful in bringing about, as indicated in a resolution adopted at the Pan-Pacific Food Conservation Conference held in Honolulu, 1924, of international agreements and understandings to provide for the giving of prompt notification of the appearance of new and destructive pests and to secure the co-operation of countries in the prevention of spread of pests.

One of the important needs in applied entomology today is accurate knowledge regarding the larval forms of insects. Consider for a moment one group alone. How many entomologists could determine definitely the more common forms of noctuid larvae - cutworms—particularly in their earlier instars, which occur in their immediate vicinities. I have often wondered why more of our younger entomologists do not investigate this most attractive field of endeavour– one which offers excellent possibilities for original and most valuable research. When accurate information is available of the larvae of even those groups of special economic importance, what a help this will be to those engaged in plant inspection work in the various countries of the world. Dr. Howard had this in mind when he stated in his recent admirable address on "The Needs of the World as to Entomology:" "We should not only be able to identify material found in whatever stage, but . . . it is becoming plain that quarantines may be promulgated which are unnecessary. We have been obliged to go on the presumption that a pest in a given country may be and probably will be a pest in another country, but such a decision cannot be made with full justice without a knowledge of the ecology of the species in its original home. It would, virtually, be impossible for any nation to carry out investigations of this kind within the territory of another nation for any number of species without international agreements and without the expenditure of large funds . . .".

Development of National Collections of Insects. We are all agreed that large and well classified collections are of prime importance. Two reasons may be advanced: (1) economic importance and (2) scientific importance. Regarding the former, in order to obtain quick and accurate determinations of insect pests, native or introduced, a well-classified collection for purposes of comparison is absolutely essential. Most of us, I think, could cite examples in support of this.

Regarding the second reason, collections are necessary from the standpoint of pure science in order to trace the relationships between existing insect forms and also between present and extinct forms; in this way one arrives at definite conclusions regarding the phylogeny of the groups and eventually may also form some definite idea regarding the laws of evolution responsible for the present distribution of insect life.

A more comprehensive interchange of material between museums would certainly be an advantage to the science of entomology. Probably the factor which principally operates to prevent this is the universal lack of adequate staffs in museums. As a rule the scientific members of the staff are already hampered by having too much clerical or mechanical work, and thus they shrink from the labour involved in making exchanges with other institutions.

I trust the time will soon come when it will be possible for museums to employ more workers in systematic entomology. Owing to the great multiplicity of insect forms and the mass of literature concerning them, it is now impossible for any single trained entomologist to master more than one order of insects—often not even that. If one worker is called upon to make identifications in all groups, it stands to reason his work will be inaccurate.

In this connection it is of interest to note that at the Third International Congress of Entomology, held at Zurich in 1925, the following resolution was passed: "The Congress considers it essential that the problems underlying Applied Entomology should be studied, and desires to impress upon Governments and Institutions concerned with investigations in Applied Entomology that time must be devoted to Systematic Entomology and fundamental research, such as Insect Physiology, Ecology and Pathology, since only by the study of these can insect control be placed on a sound basis."

INTERCHANGE OF WORKERS. International entomology should be benefitted by recommendations proposed by the League of Nations. The Fifth Assembly at its session of September 23rd, 1924, adopted a resolution inviting the adhering States to consider favourably applications for measures to facilitate interchanges of students and to grant travelling facilities to duly qualified teachers and scholars going abroad in the interest of science—further to found scholarships for the purposes indicated.

I have no information at this time as to the success attending such undertakings, but it is a pleasure to note that many countries have approved of the suggestions laid down and it is hoped that the science we are all specially interested in will in future years be advanced thereby.

I understand that the Department of Scientific and Industrial Research of Great Britain is of the opinion that great benefit would result from an exchange of scientific workers within the British Empire.

The report of the special sub-committee on Research of the recent Imperial Conference (1926) approved of the importance of providing facilities for the free interchange of officers between different services and for study leave to enable officers to keep in touch with the latest developments in their branch of science. It is obvious, of course, that an international arrangement for the exchange of research workers could be of even greater benefit.

These remarks are intended to refer particularly to governmental action regarding the interchange of workers. Most of us have knowledge of certain foundations and other organizations which have assisted. The International Education Board, for instance, has for its purpose the promotion and advancement of education, whether institutional or otherwise, throughout the world. Scholarships for overseas studies are awarded to young scientists of unusual promise and provision is made whereby financial aid may be given to institutions to assist outstanding research in the pure sciences and in agriculture.

ENTOMOLOGICAL FORECASTING. During recent years, as we all know, important advances have been made regarding the bionomics and habits of insects, particularly in those countries of the world where applied entomology is being developed. As a result of knowledge obtained, it has been possible to forecast outbreaks of white grubs, certain kinds of cutworms and other insects. For instance, in connection with outbreaks of the pale western cutworm, it has been demonstrated both in Alberta and Montana that the amount of rain falling in a given year has a distinct bearing on the abundance of the cutworms the following year. Such knowledge has been of great value in anticipating outbreaks and thus avoiding losses to grain crops. As regards white grubs the entomologist has been able to forecast injury to certain kinds of crops if grown on infested land. A method of forecasting dates when the different stages of the several generations of the codling moth may be expected to appear at any given place in a normal season, has been presented by Glenn of Illinois. Headlee, Shelford, and others have also been keenly interested in such investigations.

Detailed studies made by forest entomologists indicate that future outbreaks of the spruce budworm may be avoided by an improved system of forest management.

Other observations could be made but these brief references indicate the increasing importance attached to all research which will in any way

assist us in forecasting outbreaks of injurious insects. As Hyslop has said[1] the data obtained as a result of insect pest surveys should be of far reaching value in connection with entomological forecasting.

THE AMATEUR ENTOMOLOGIST. Is the rank and file of amateur entomologists increasing or decreasing? My observations would indicate that there has been a noticeable decrease. I hope I may be wrong in this, but if correct, what is responsible for this decrease? Is the economic entomologist encouraging the study of insects among those who possibly have not the same opportunities for research that he has? Personally, from what I have seen I rather doubt that he is. There is usually little time for the one engaged in problems of applied entomology to devote to the encouragement of some of those at least who have the aptitude, if directed, of contributing to scientific knowledge. Probably I should not say little time, because most of us I think could find some time to assist some one of our acquaintance who would welcome a guiding hand.

We all know that much of the splendid work of the past has been accomplished by amateur entomologists—men who loved the work for itself and not for any personal advantage. What can we do towards developing a future corps of amateur workers to fill the places of even such recently deceased authorities as Harrington, Wolley-Dod, Kearfott, Elwes, Casey,—to mention only a few.

At a meeting of the Royal Society of Canada, held in May, 1926, the question of encouraging natural history studies in the field among university students and others was discussed with committees appointed by the Royal Society, the Ottawa Field-Naturalists' Club and the Royal Canadian Institute. At this discussion in which several university professors, government officials and others participated, it was more or less openly admitted that perhaps one of the main reasons why students, particularly university students on this continent, did not seem to take the same interest in natural history studies in the field as did university students in Europe, was to be found in the curricula of the universities which in instances do not make provision for natural history studies in the field.

Perhaps we as an Association in co-operation with other organizations, such as our sister society, the Entomological Society of America, could do something to encourage a wider interest in many phases of research, particularly along lines of pure science.

Just one or two further remarks in closing. In the future welfare of the world the entomologist is undoubtedly destined to take a most

[1]U. S. Dep. Agric. Bull. 1103.

important part. The warfare against the insects is becoming more necessary year by year. Insect pests the world over are taking on new habits, developing into huge armies, and in fact are threatening the very foundations of our civilization. The members of this Association, the largest and most important of its kind in the whole world have a responsibility which I am glad to note they are not only recognizing but also imparting to other scientists, particularly to the younger students who are daily joining up for service. None of us can look to the future with certainty, but your President feels that, with the splendid interest in the success of all of this work which is developing and which we have personal evidence of at our annual meetings, victories of very great importance will be achieved in future years not so very far distant.

VICE-PRESIDENT C. J. DRAKE: The President's address is now open for discussion.

MR. A. F. BURGESS: Mr. President, I would like to say a few words of commendation in connection with this address of our President. I think it is an unusual address. I don't know when we have had a presidential address that has covered the field and the scope that this one has. I was particularly impressed with his introduction and opening remarks, where he paid tribute to Dr. Fletcher and to Dr. Howard. Probably many of the men here were not personally acquainted with Dr. Fletcher. Dr. Fletcher was one of those wonderful men whom it was a great privilege to come in contact with.

I certainly enjoyed the address and I am sure the other members did also.

MR. L. O. HOWARD: I want to endorse what Mr. Burgess has said. We have heard a very broad and remarkable address.

Referring to James Fletcher, this organization is largely the idea of Fletcher. He came down to Washington in the middle of August and we sat down and drafted that original Constitution. I don't think Fletcher, who was an optimist, ever for a moment visioned what this organization would grow into. If there is such a thing as the departed knowing what is going on here, then I think Fletcher today is enjoying listening to his old assistant President Gibson talking about entomology in such a way and saying such nice things about him.

I think President Gibson is to be heartily congratulated upon this address.

Adjournment: 12:45 p. m.

Thursday Morning Session December 30, 1926, 9:40 a. m.

The meeting was called to order at the above time by President Arthur Gibson.

PRESIDENT ARTHUR GIBSON: The first paper is by E. P. Felt.

INSECT PESTS NEWLY ESTABLISHED IN NEW YORK STATE

By E. P. FELT, *State Entomologist, Albany, N. Y.*

ABSTRACT

The recent appearance of three Japanese beetles in New York State, namely the Japanese beetle, *Popillia japonica* Newm , limited for a number of years to New Jersey, the Asiatic beetle, *Anomala orientalis* Waterh., and a Japanese Serica, *Aserica castanea* Arrow, is recorded. The grubs of all three are serious pests to sod, particularly lawns and golf greens. The Japanese beetles, so well known in New Jersey, are voracious feeders upon the foliage of a number of fruit and shade trees in particular. Earlier investigations in that state have shown that there are practical measures for the control of this insect in both larval and adult stages. There are also brief records, with an indication of the economic status of certain insects which have become established in the state during the past twenty-five years; as follows: Birch Leaf Miner, *Fenusa pumila* Klug.; Gipsy moth, *Porthetria dispar* Linn.; Chrysanthemum midge, *Diarthronomyia hypogea* Lw.; European corn borer, *Pyrausta nubilalis* Hubn.; Imported Pine Saw Fly, *Diprion simile* Hartig; The Apple and Thorn Skeletonizer, *Hemerophila pariana* Clerck; Oriental Peach Moth, *Laspeyresia molesta* Busck; European Hornet, *Vespa crabro* Linn.; European Pine Shoot Moth, *Evetria buoliana* Schiff.; Box Midge, *Monarthropalpus buxi* Labl.; European Earwig, *Forficula auricularia* Linn.; Spruce Bud Scale, *Physokermes piceae* Schr.; and European Elm Case Bearer, *Haplotilia limosipennella* Dup.

The appearance the past summer of considerable numbers of Japanese beetles, *Popillia japonica* Newm., in a number of localities in southern Westchester Co., on Staten Island and the western extremity of Long Island and the recognition of several infestations within this general area of two other Japanese beetles, namely the Oriental beetle, *Anomala orientalis* Waterh., and another species determined as *Aserica castanea* Arrow, and termed by us the Japanese Serica, very naturally aroused considerable interest in the local situation and has prompted this brief discussion.

It is fortunate for us in New York State and presumably for residents in other eastern states at least, that the Japanese beetle has for a number of years been limited to New Jersey and as a consequence the habits of the insect, its destructive possibilities and promising methods of control have been pretty thoroughly investigated. It must be conceded at the outset that spread of this insect can at best be retarded. There is no possibility of holding it at any given point. The experiences in New Jersey during the last few years indicate that certain methods, namely

judicious spraying with an arsenical and treatment with an emulsion for the destruction of the grubs would prevent serious injury. There is no reason why this insect should be allowed to become excessively abundant and destructive in the newly infested areas and we believe that good policy dictates emphasis upon possibilities of control in order to avoid serious damage. It is believed furthermore, that fairly satisfactory control will also aid materially in checking rapid spread of the insect. It is evident that the beetles have established themselves in some numbers at least fifty miles from previously known infested territory and with this in mind the insect may be expected to make somewhat rapid progress up the Hudson Valley, presumably being aided by favorable winds.

Infestations by the Asiatic beetle, *Anomala orientalis* Waterh., evidently of some years standing, are known to occur at White Plains, New Rochelle, Mt. Vernon, Westchester County, and at Jericho on Long Island. The adults are evidently much more local in habit than the Japanese beetles and not nearly so destructive to foliage though these feed to some extent upon blossoms, particularly roses. The grubs when numerous are very injurious to sod.

The Japanese Serica, *Aserica castanea* Arrow, although identified as occurring in this country only last summer, was found at Mt. Vernon, Westchester Co., in 1923, the species then being identified as *Serica paralella* Casey, and at that time was definitely associated with serious injury by the grubs to lawns and with material damage to smaller garden plants by the adults. This insect is widely distributed in Mt. Vernon, and also occurs in New Rochelle and more recently has been reported from Yonkers. There are also reports of this insect occurring in two northern New Jersey localities. The adults are somewhat voracious feeders and when abundant may cause considerable injury, especially to plants in small beds. It is difficult to estimate the economic status of this Japanese beetle and the Anomala mentioned above, though the known history of these two insects in this country suggests that they will be much less difficult to control than the much better known Japanese beetle of New Jersey fame.

It is interesting in this connection to turn to some other recently established insects in New York State in order to make comparisons.

The Birch Leaf Miner, *Fenusa pumila* Klug., was first recognized in this country in 1923 though it was not identified until Dr. Britton reared adults and sent them to Washington for determination. This miner affects the younger foliage of sprout birch in particular and when abundant may give a brownish cast to large areas, consequently its

presence and spread is easily determined. The insect now occurs throughout southern New England, Long Island, eastern New York and northern New Jersey, the small saw fly adults evidently drifting readily with the wind. It has occasioned some concern among nurserymen in the vicinity of New York City on account of its disfiguring the foliage of young trees. Generally speaking it cannot be considered a serious pest.

Gipsy moth, *Porthetria dispar* Linn. The general westward spread of this insect resulted in a few colonies being found in eastern NewYork State in 1922 although there had been infestations in earlier years, the latter due to commercial agencies. The threatened westward spread was prevented by the establishment in 1923, of a barrier zone extending from Long Island Sound northward through the Hudson and Champlain valleys to the international boundary. Since then there have been minor infestations found from year to year within this area. These have been cleaned up and the insect has been prevented from securing a permanent foothold in the forbidden area.

Chrysanthemum midge, *Diarthronomyia hypogea* Lw. This European midge was first detected in New York State about 1920, although it was found earlier in other section of the country. It is primarily a pest of cultivated chrysanthemums and when numerous causes serious damage. It is by all means advisable to prevent infestation by keeping the greenhouses cleared and admitting only plants which are free from the pest.

European corn borer, *Pyrausta nubilalis* Hubn. This insect was first found in New York State near Schenectady in the winter of 1919 and that fall an infestation was located in western New York. There has been a gradual and rapid spread particularly in the western area, so that at the present time about two-thirds of the arable land of the state is infested although commercial injury is practically restricted to a small area near Schenectady and to towns bordering Lake Erie or those adjacent thereto. It seems very probable that much of the spread in the western part of the state has been due to favorable wind currents, and a marked limitation of serious injuries to lowland near water suggests that material damage may not be general throughout the state. It is unsafe to depend upon this and growers in all infested areas are urged to adopt such modifications in handling the crop as will reduce the infestation to a minimum and prevent serious losses.

Imported Pine Saw Fly, *Diprion simile* Hartig. This saw fly appeared in New York State about 1918. It has caused some injury in the vicinity of New York City and is known to be established in the city of Rochester.

The Apple and Thorn Skeletonizer, *Hemerophila pariana* Clerck, was first recognized in this country in 1917, it being extremely abundant in

a limited area of Westchester County. There are three broods usually. The spread of this insect has been very rapid though not equal to that of the Birch Saw Fly mentioned above. Observations in 1922 and 1923 showed that the insect spread northward fifty to seventy-five miles each year, the infestation not only occurring in the orchard sections but also appearing even upon isolated apple trees here and there in rather densely wooded areas. The past season, 1926, it has been reported from central and western New York. The caterpillars feed upon the upper surface of the leaves and the insect is easily controlled by the usual spraying for orchard pests, consequently it is of little importance except in areas where spraying is not practiced.

The Oriental Peach Moth, *Laspeyresia molesta* Busck, was somewhat generally distributed on Long Island in 1916 and apparently did not spread northward and westward until the last few years. There have been no unquestioned records of the insect occurring any great distance from the vicinity of New York City, prior to the past season. It was then found and has been recorded from several Hudson Valley localities and from sections in western New York. The status of the insect as a pest in our section remains to be determined.

The European Hornet, *Vespa crabro* Linn., was recorded in the vicinity of New York City about 1914 and in 1918 had become established in southern Rensselaer County. The insect is not of much economic importance. The hornets damage shrubs by gnawing the bark from the branches, evidently for the purpose of obtaining material from which to construct nests. The past season, a specimen of lilac about 1½ inches in diameter showing a series of transverse scars, presumably made by these insects, came to our notice.

European Pine Shoot Moth, *Evetria buoliana* Schiff., was recognized in the vicinity of New York City in 1914, is now widely distributed throughout the state and causes some injury to ornamentals here and there, though the damage can hardly be considered as general and serious.

Box midge, *Monarthropalpus buxi* Labl. This insect appeared in the vicinity of New York City about 1913 and is now generally distributed in the residential areas where box is somewhat commonly grown. It multiplies enormously in some localities and causes such serious injury that estate owners have been compelled to spray for the insect or take the chances of serious damage to this valuable ornamental.

European Earwig, *Forficula auricularia* Linn., was reported from Aurora, near Buffalo, in 1912. Recent investigations indicate that the insect has held its own in that locality and presumably has become well

distributed throughout the village, though without having occasioned serious injury or annoyance.

The Spruce Bud Scale, *Physokermes piceae* Schr., was first identified in New York State in 1908. It is generally overlooked though it apparently causes material injury. It occurs as budlike clusters in the forks of the smaller branches and appears to be responsible for the death of twigs and in some cases produces a very unsightly condition.

European Elm Case Bearer, *Haplotilia limosipennella* Dup., was first brought to notice in New York State in 1901. It is somewhat generally distributed in the Hudson Valley at least and occasionally causes rather severe injury to European elms on Long Island. It is a local insect sometimes so abundant as to produce conditions suggestive at a distance of nearly complete skeletonizing by the Elm Leaf Beetle.

PRESIDENT ARTHUR GIBSON. The next paper is by C. H. Hadley.

THE STATUS OF SEVERAL IMPORTED PESTS IN PENNSYLVANIA

By C. H. HADLEY, *Harrisburg, Pa.*

(Paper not received in time for publication)

PRESIDENT ARTHUR GIBSON: We will now listen to a paper by E. O. Essig.

SOME HIGHLIGHTS IN THE HISTORY OF THE DEVELOPMENT OF ENTOMOLOGY IN CALIFORNIA

By E. O. ESSIG, *University of California, Berkeley*

(Withdrawn for publication elsewhere)

PRESIDENT ARTHUR GIBSON: The next paper is by A. F. Burgess.

SOME PROBLEMS IN ECONOMIC ENTOMOLOGY

By A. F. BURGESS, *Bureau of Entomology, Melrose Highlands, Mass.*

ABSTRACT

The life of the Entomologist is crowded with problems and the larger the organization the more difficult becomes their proper solution. Under present conditions and probably for a long time in the future the satisfactory control of introduced pests that are destructive to

crops or seriously effect human welfare will require the best efforts of the economic entomologists. The public will demand and will require that remedies be found to relieve serious losses. Research must discover effective control measures that can be applied in a practical way or the work of the Entomologist is doomed to failure. So far as foreign pests that may at any time be brought to this country are concerned, every effort should be made to secure full information relative to their biology and habits before they arrive here. This is a field that has been given little attention. There is no question but that all information that can be secured along this line will prove extremely useful to American entomologists in the future.

The success of economic entomology in this country rests largely with the Entomologists themselves. Under present conditions most of the research and control are directed by government, state or provincial activities and largely on account of lack of uniformity of laws and regulations perfect cooperation is seldom secured. It cannot be too often repeated that "cooperation" means more than mere written agreements. It is a state of mind which will bring about mutual assistance in order that the problem at hand can be effectively solved. In the business world where profits are the major consideration results have been obtained by frequent consolidations and centralized control. The same results should be secured by the entomologists by wise leadership backed by effective cooperation.

This association is or should be the great clearing house where all entomologists can freely exchange views and arrive at a common understanding. Its development should be fashioned so that it will become increasingly effective in this respect, and the accomplishment of this purpose will tax the best efforts of the membership.

PRESIDENT ARTHUR GIBSON: Mr. Alan G. Dustan will read the next paper.

THE ARTIFICIAL CULTURE AND DISSEMINATION OF *ENTOMOPHTHORA SPHAEROSPERMA* FRES., A FUNGOUS PARASITE FOR THE CONTROL OF THE EUROPEAN APPLE SUCKER (*PSYLLIA MALI* SCHMIDB.)

By A. G. DUSTAN, *Entomological Branch, Ottawa, Canada*

The European Apple Sucker (*Psyllia mali* Schmidb.) was introduced into Nova Scotia some time prior to 1919, the year when it was first found in that province, and has become a serious pest in commercial apple orchards. It is attacked naturally by a fungus parasite, *Entomophthora sphaerosperma* Fres. which is present in varying

abundance in normal seasons. This disease has been grown artificially in cotton covered cages under favourable temperature and humidity conditions and material from this source spread successfully into suitable orchards throughout the infested districts.

The European apple sucker (*Psyllia mali* Schmidberger), long recognized as a serious pest of apples in many countries of Europe was discovered in the summer of 1919 in orchards surrounding Wolfville, Nova Scotia. This was the first record of the insect for America. Since the above mentioned date, however, the spread of the apple sucker has been rapid and it is now found in seven counties of Nova Scotia and two counties of New Brunswick, despite the fact that its progress was impeded by strict quarantine measures and by such natural barriers as wide stretches of water and extensive marshlands.

LIFE HISTORY AND ECONOMIC IMPORTANCE. The insect passes the winter in the egg stage, the eggs being laid in the autumn on the twigs of apple trees. The eggs are yellowish to orange in color, elongate-cylindrical and averaging .4 mm. in length. With the coming of spring the nymphs emerge, usually about the first week in May, and commence feeding on the bursting buds. They are much flattened dorso-ventrally and in the first four instars are orange to greenish-yellow in color. In the last stage they are pale green. Honeydew is secreted profusely in all instars. The nymphs feed at first on the opening buds but soon transfer their attention to the unfolding blossoms, clustering on the pedicles and more particularly in the axils of the flower stems. When approaching maturity they wander freely over the leaves, feeding as they go. They become fully grown in four to five weeks, the adults appearing early in June. The winged forms are pale green in color, very active and have the habit of springing into the air when disturbed. Egg laying does not commence until late August and continues through the autumn up to the time when heavy frosts are experienced.

In heavily infested orchards the insects are present in enormous numbers, over one hundred nymphs sometimes feeding in a single blossom cluster. Under such conditions severe blossom injury results, the insects sucking the juice from the flowers and causing them to turn brown and eventually die. In such orchards the set of fruit is materially reduced. A certain amount of foliage injury also takes place as a result of the feeding of the insects. Yellowing and browning of the leaves is frequently seen, the injured foliage falling prematurely. Such excessive feeding greatly weakens the vitality of the tree and results in a very much lighter crop of fruit. In the case of severe infestations, more

particularly when the bloom is fairly light, the whole crop may be destroyed.

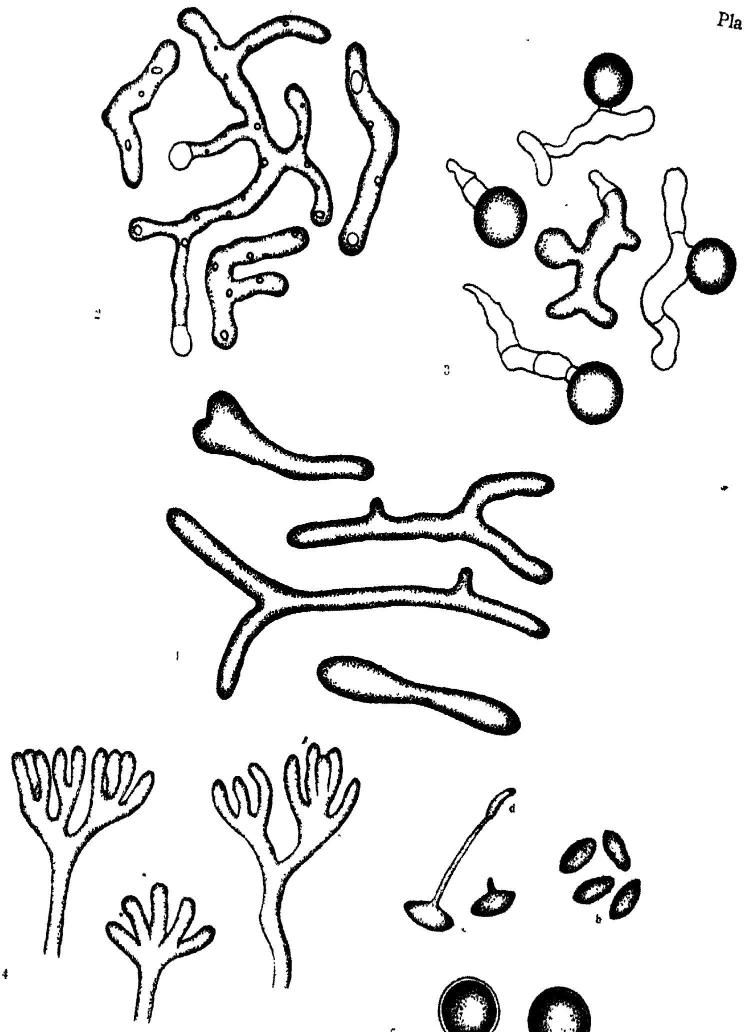
NATURAL CONTROL FACTORS. Biological studies in connection with the apple sucker have shown that in the field the insect is reduced numerically to a limited extent in practically all stages. Insect parasites are wholly lacking but among the predators, birds, ants and spiders take an important toll of nymphs and adults. The economic control brought about by such factors is ineffective, however, compared to that exercised by the fungous parasite, *Entomophthora sphaerosperma* Fres., which in normal seasons plays an important part in checking the insect. This disease has been studied throughout a period of five years and has been shown to be of prime importance. It grows profusely in average years and under Nova Scotian conditions, lends itself readily to artificial culture and dispersal. This paper has been written with a view to outlining in some detail the methods used in culturing and disseminating this organism which have been gradually evolved from control experiments carried on in the field.

NOTES ON THE BIOLOGY OF *Entomophthora sphaerosperma* FRES. The fungus passes the winter in the resting spore stage, the spores being found in the bodies of dead insects adhering to the fallen leaves. In the late spring and early summer these germinate and in all probability give rise to conidia by means of which primary infection takes place. The process of germination has been watched in hanging drops of sterile water and although hyphae have been seen to grow out from the spores no conidia were formed. As primary infection takes place in the case of many other fungi in this way it seems reasonable to infer that a similar method is utilized by *Entomophthora sphaerosperma* particularly as germination of the resting spores has been actually observed.

In the orchard the nymphs are never attacked but after the organism has gained entrance to the body of the adults it develops, first, in the blood stream of the host. Many of the parasitized forms have been examined and it has been found that the fungus always grows by means of short mycelial threads that look like but fragments of mycelium (Plate I, fig. 1). They do not resemble the stout peculiarly shaped hyphal bodies that are found in many insects attacked by fungous parasites, and yet they are much shorter than the individual filaments which usually make up the ordinary fungus mycelium.

The fungus invades all parts of the host; the head, thorax and abdomen are readily attacked and mycelium may be found in the legs, even down as far as the tarsi. The organism continues to grow until all the internal structures of the host have been destroyed and, when the disease has

Plate 1



1, Mycelium from live adult showing type of threads in conidial stage. 2. Mycelium from dead adult prior to formation of resting spores. 3, Stages in the formation of resting spores. 4, Conidiophores. 5, Spores (a) Resting spores, (b) Conidia, (c) Germinating conidia, (d) Secondary conidium. (Original.) Magnification of all figures about 400 diameters.

fully developed, what was once an insect consists merely of a chitinous shell filled with fungous threads.

Shortly before this last stage in the development of the fungus is reached, the insects lose their power of locomotion and either drop to the ground or settle down on the underside of the leaves, preferably on those growing low down on the tree. The manner in which the conidiophores are produced from the mycelial filaments is not very clear, but after the fungous has reached its maximum growth hyphal threads commence to grow out through the integument. These probably are formed by the continued growth of the internal threads of mycelium. The majority of the hyphae emerge through the dorsum and eventually form the conidiophores, (Plate I, fig. 4) but some grow through the ventral sides and form rhizoids which, with the help of the beak and legs, fasten the dead insects to the leaves.

With the exception of a small area at the centre of the thorax, which is always bare, the hyphal threads grow profusely from all parts of the dorsum, spreading out laterally and in all directions but very rarely growing upward. As a result, the fungus, when mature and fully grown, appears as a dense, flat mat of mycelium spreading out radially from the dorsum of the insect which it completely covers, with the above mentioned exception. The mycelium varies greatly in color, being white or pale blue in most forms, but occasionally green specimens are met with and one or two red ones have been seen.

At first these threads are simple but as they elongate branches are formed at the tip and when fully grown each conidiophore bears at the apex a cluster of short, stout, irregular branches. Here the conidia are born (Plate I, fig. 5b), one being produced on each branch, whence they are shot off into the air to reinfect other insects. Successive generations of these summer spores may be produced in this manner throughout the whole season, so long as the temperature and relative humidity is favorable to growth and the host insects are present in sufficient numbers.

A short time after the fungus makes its appearance occasional insects are to be seen in the infested orchards which, although they show no external signs of the disease, yet are dead and attached to the underside of the leaves. Upon examination of one of these insects it is found to be filled with resting spores (Plate I, fig. 5a). These spores completely fill the body and can easily be discerned in the head, thorax and abdomen, including the legs.

Just what condition brings about the formation of resting spores has not been ascertained. Apparently the time of year has little to do with it, since they arise as readily in June as in October and appear almost

at the same time as the conidial stage. Probably a lowering of the temperature or a short period of dry weather at certain periods in the development of the organism produces the stimulation necessary for the formation of these spores.

It is interesting to note that the mycelium from which the resting spores are produced differs very considerably from the fungous threads that are present in the summer stage. In both cases the fungus grows in the form of short mycelial fragments but while these threads are smooth and regular preparatory to the formation of conidiophores, they are very rough and irregular in the resting spore stage (Plate I, fig. 2) Large knobs appear at various points along the threads and wart-like protuberances and swellings are found at their ends. These protuberances and swellings apparently give rise to the resting spores, for specimens have been examined in which the successive steps in their formation could be easily traced (Plate I, fig. 3). No sexual process was observed either prior to or during spore formation.

METHODS USED IN ARTIFICIALLY SPREADING THE FUNGUS. Realizing the importance of *Entomophthora sphaerosperma* as a control factor in the suppression of the apple sucker, a detailed study of the fungus was commenced in 1921 with a view to learning whether or not the disease lent itself to artificial dispersal and if it was possible to increase the scope of the epidemics each year by some such means.

Under natural conditions the spread of the fungus from one locality to another was too slow, when the time for such dispersal was often very limited, and it was hoped to accelerate the spread from orchard to orchard and from one locality to the next by some artificial method. This investigation was continued over a period of five years and at the end of that time it was evident that the fungus could be successfully spread in normal years and was a factor of prime importance in checking and controlling the insect.

A number of methods were tested with varying success but the following three, in the order listed, appear to have given the best results. (1) Where leaves bearing diseased adults were gathered in fungous-infected orchards and pinned to the under side of the foliage in the orchards to be infected. (2) Where flying adults were collected by means of nets in orchards where the disease was present and liberated in orchards at that time free from the fungus. This method was tested only after dissections of live insects from infected orchards had shown that fifteen per cent of them carried the disease in the blood stream. (3) Where young nursery trees planted in cotton covered cages were first infested

with disease-bearing insects and then transplanted into the orchards to be treated.

These methods were modified in different ways, in some cases the "plantings" were made in the morning and in others in the afternoon. In some orchards the insects were all liberated or pinned on a central tree while in others they were generally distributed through the orchard on a dozen trees or more. Although the differences were very slight it was thought that results were a little better when the insects were distributed on several trees in an orchard and when the "plantings" were made in the morning before the dew had dried.

Usually about a week after the diseased material had been placed in the orchard under experiment the fungus began to appear. Once started it spread very rapidly and within two or three weeks, providing the weather was favourable, was generally distributed throughout that orchard. As soon as the disease became firmly established, no further "plantings" were made, but another orchard was chosen, either in the same district or in another locality altogether, depending on whether the disease was being spread intensively in one section or started at widely separated points. These orchards served as foci of infestation for that particular district.

Regarding the number of "plantings" required to start an epidemic in any orchard this also varied greatly with the weather, with the type of orchard and the degree of infestation. As a rule two or three "plantings" sufficed to start an epidemic but sometimes more would have to be made. When the insects were introduced on leaves, two or three hundred were usually brought in at one time, while each "planting" of live insects, although hard to estimate, must have contained thousands of apple sucker adults. Once the disease gained a foothold in an orchard the insects themselves, by natural migration, assisted greatly in spreading the epidemic; not only to different parts of that orchard but from one orchard to the next.

After the work had been in progress a year or so it became evident that in normal seasons the disease appeared in the field under natural conditions too late to be as effective as it might have been had material for spreading been available earlier in the summer. This was due to the fact that in Nova Scotia the weather throughout May and June was too cold for the proper development of the disease.

Our studies had shown that fungus development and the outbreak of epidemics was dependent almost entirely on three factors, namely, correct relative humidity, a relatively high temperature and an abundance of the host insect. In the absence of any one of these three factors

it is impossible to produce an outbreak but given a suitable temperature and humidity in the presence of a large number of the insects an outbreak is assured.

Accordingly it was thought advisable to investigate the growing of this disease in cages in the early part of the summer where the temperature and humidity could be to some extent regulated and the number of insects increased at will.

At the commencement of the work three types of cages were tested, frame cages covered with plain factory cotton; similar cages in which the cotton was treated with parawax with a view to holding in the moisture and cold frame cages having wooden sides made of matched lumber and supplied with tightly fitting, removable glass tops under which was stretched a factory cotton screen to prevent the insects from escaping when the glass was removed. All cages measured 30 inches in length, 15 inches in width and 20 inches in height.

The cages covered in each case a number of apple seedlings on which the insects lived and fed and contained a supply of leaves saved from the previous year bearing an abundance of adults killed by the disease and filled with resting spores. The leaves were distributed on the ground at the base of the seedlings and served as the source of primary infection These experiments were started as soon as the apple sucker adults appeared, usually about the first week in June.

By the use of thermographs and self registering thermometers it was learned that the highest temperature was reached in the waxed cages, the cold frame cages came next and the untreated factory cotton cage showed the least thermal increase. To give some idea of the increased temperature obtaining in these cages our records show that when the maximum temperature registered eighty degrees in the shade in the open, the waxed cage showed a maximum of one hundred and one degrees, the cold frame cage ninety-one and the cotton cage eighty-five. The minimum temperatures in the different cages did not show as much variation as the maximum temperatures, although the minimum in all cases stood six degrees higher than the prevailing temperatures at the same time in the open. It is interesting to note in this regard that the minimum in the cold frame cage never dropped quite as low as it did in the other two types of cages.

The relative humidity in the cages was increased by spraying the soil within the cages and the cages themselves a number of times each day with warm water depending on the weather prevailing. In this way it was possible to keep the relative humidity in the cotton, waxed and cold frame cages up to a maximum of ninety-one, ninety-three and nine-

ty-four degrees respectively over a period of weeks when the humidity in the open stood around eighty degrees.

From these brief notes it can be seen that in its ability to produce an increased temperature and relative humidity and to retain them throughout the twenty-four hours the cold frame cage was superior to all others and was adopted as the standard in our work.

As a result with this equipment it was found that epidemics could be started under cage conditions a month to six weeks earlier than ever took place in the orchards. Material from the small cages was transferred to large factory cotton cages where a more extensive supply of the fruiting stage of the fungus could be reared. These larger cages were built over moderate sized apple trees which in some cases were twenty feet or more in height and capable of supporting an immense insect population. Here the disease was cultivated and when favourable weather prevailed the fungus distributed into suitable orchards. These orchards then served as foci of infection and the disease spread from them into the surrounding country both naturally and by means of the artificial methods outlined earlier in this paper.

Our work in rearing and spreading this fungus has met with unexpected success, for it has been found a comparatively easy matter in years of average rainfall to grow the disease in cages and start epidemics in the field from that source. We feel that our success has been due largely to the climatic conditions prevailing in the Maritime Provinces, and more particularly to the rather heavy summer rainfall, the presence of fogs coming in off the ocean and the generally humid atmosphere experienced there. Also the fact that we were working with a single brooded insect which was liable to attack by a fungus parasite for a period of over four months, during some part of which time it was practically assured that optimum conditions would be met, had a very direct and important bearing on the problem.

MR. ALBERT HARTZELL: I would like to ask if that fungus has ever been grown in culture.

MR. ALAN G. DUSTAN: No. I have made several efforts of wide variety but have never been able to get the fungus to grow.

PRESIDENT ARTHUR GIBSON: We will now listen to a paper by J. A. Manter.

CHARTS AND FORMS AS AIDS IN TEACHING ECONOMIC ENTOMOLOGY

By J. A. MANTER, *Connecticut Agricultural College, Storrs, Conn.*

The future entomologists are now receiving their initial training in our colleges and universities. The future development of the science of entomology depends largely upon the character of the education of these young men and women. It is doubtful that the teaching of entomology has reached as high a standard on the average as the teaching of some of the other sciences. Certainly there is much opportunity for improvement. The teachers in other subjects have organized themselves in order to bring about better teaching methods. It has been my hope that the problems of the teacher of entomology could have a larger place on the programs of this or some other organization. Perhaps one important reason why this has not occurred is because the teachers themselves have not brought their problems before these meetings in their papers. I know that the majority of our members are research workers and that all of us are keenly interested in the newer facts that they bring to these meetings. However, so many of our members teach, at least a part of their time, it would seem that they could spend at least one session in discussing pedagogical methods which would be of great importance in improving the teaching of entomology and result in the advancement of our science. These thoughts have given me courage to offer a small contribution in the hope that other teachers will give us the results of their experience.

I believe it necessary in teaching about insects to attack the problem from different angles, to secure different viewpoints, and to use varying methods. No one method will suffice. To study a series of insects one after the other, soon leads to great confusion on the part of the student. Many expedients have to be tried to keep the student out of this maze. The teacher of economic entomology does not have difficulty in securing plenty of subject matter in textbooks and bulletins. Because of this wealth of information there is little need for lectures. The very abundance of source material, however, makes it difficult for the student to pick out the essentials which he should learn. An attempt to overcome some of these and other difficulties, has led to the development and use of certain charts and forms at the Connecticut Agricultural College. Other colleges also have in use similar aids.

The "INSECT SHEET" has gone thru a process of evolution covering a period of several years. At first we had many more headings and subheadings than on the one in use at present. Many of these were elim-

inated from time to time to simplify the sheet, to emphasize the essentials, and to make the sheet more generally applicable. The following general information is needed to fill out one of these insect sheets; classification of the insect, plant, animal or material injured, characteristic type of injury, types of mouthparts and metamorphosis, description of stages, connected life history, economic importance, control measures, references, and drawings made from the insect and its work. I believe the use of the insect sheet aids the student in organizing his material, helps him in selecting the essentials, offers a chance for efficient reviewing, and is an aid to memory. There are some disadvantages in its use, such as, the ease with which one man may copy the work of another. The student must be shown that the filling out of the insect sheet is not the end in view but merely a means to an end,—simply a method of study.

Field work with living insects under natural conditions is very valuable in training the student. To see the insect at work and the injury that it is doing makes a more lasting impression than reading or hearing about them. Students enjoy these field excursions but often think of them as pleasant outings rather than opportunities to secure valuable instruction, thus getting little of lasting benefit from them. I have used the "INSECT FIELD REPORTS" as one means of holding the class to real work while on field trips. In order to complete one of these in the field, the student must make certain observations and deductions. The necessary observations have to do with the location and abundance of the insect, the plant attacked, the amount of injury, and descriptions of the injury and of those stages of the insect found. As the aim of the field work is to gain acquaintanceship with insects and their work, the field report asks the student to determine the characteristic markings of the insect so that he may identify it again and to observe the character of the injury that he may recognize it at any future time. The student will take better notice of the remarks and information given by the instructor and will observe more carefully the insects pointed out to him when he knows that he may be asked to fill out these field reports.

It is not easy for the student to learn the life histories of many insects without becoming more or less confused. He has a better chance of keeping these straight if he studies them by different methods and from different sources, such as; textbooks, reference bulletins, field studies, laboratory work, insect sheets, life cycle charts, and class discussions. To fill out the "LIFE CYCLE CHART" the student must determine the seasonal occurrence of the various stages of the insect. This chart has been made into a rubber stamp so that it can be reproduced where-

ever it can be used. The chart is circular in form, divided into sectors for the 12 months of the year. This arrangement gives a good idea of the cycle thru which the insect passes in the yearly cycle of months. It cannot be used without some additional data for insects requiring more than one year for their development and is not suitable for insects that have several generations a year. I think it better to indicate on the chart the periods of time during which the various stages of the insect are present rather than to attempt to chart the periods for an individual insect. Thus the student has the seasonal cycle for the species as a whole. An interesting exercise is to give some of these completed but unnamed charts to a class for identification. This leads to real concentration on the part of the student much as the solving of a puzzle. Both the insect sheet and the life cycle chart are useful when giving written quizzes.

The academic year does not include the best season for the studying of living insects but some species can be reared in the laboratory at any time of the year. Students should handle and rear as many insects as possible. It is difficult to have them appreciate the importance of making exact and complete data at regular intervals. An "Insectary Record" with appropriate captions for the students to use results in more exact scientific methods on their part.

The four forms and charts, illustrated by lantern slides, together with others, have been found useful and of aid to students altho it is realized that they are not without faults. The teacher needs to be constantly on the alert to take advantage of everything which will make his teaching more efficient, as all of us would like to see our profession reach a high standard along with the best

Mr. L. S. McLaine expressed a wish that some of the teachers might express themselves as to whether they should like to have a symposium arranged on teaching methods at the next meeting.

Mr. C. H. Richardson: I believe this question of standardization of education in entomology is such an important one that this Association should have a committee appointed to deal with it. If we are to get young men adequately trained, it would seem only right that this Association should take some part in suggesting, not in a dictatorial spirit but in an instructive way, something toward the standardization of education in entomology. I believe if we had such a committee and if they would formulate some program, the more progressive colleges

and universities would be glad to avail themselves of their recommendations.

Mr. H. T. Fernald: Some years ago I was quite interested to ascertain the methods used by the teachers of this subject and I sent out a letter of inquiry to a large number of teachers at that time. The result coming from the answers was the conclusion on my part that there was no uniform movement; in fact, hardly two places had the same methods, and the teaching plan at that time was rather chaotic.

I made that statement, or something equivalent thereto, in print and shortly afterward I received a letter from Professor Comstock in which he stated that in his opinion that was one of the most promising things about entomology today. While I do not venture in any way to oppose Professor Comstock's opinion with my own, I think it, nevertheless, is indicative of a weakness in our system of teaching. There seems to be two main lines of training students in entomology today. One is the pedagogical view of the subject of entomology; the other is the consideration of the insect pests of different crops. Comstock's book, of course, is considered as the standard for the first type of treatment, and such books as Crosby's and Leonard's and others, which I do not need to mention, are wonderful examples of texts for use in the study of the insects affecting different crops.

I think that the determination of the line followed will prove finally to be determined not so much by the desire of the teacher as it will by the demands and needs of the students at the particular place where he teaches. In some places the presentation of entomology as a whole is the pedagogical, natural thing to start with, while in others the restricted aims and desires of the student body taking the subject will lead to a study of the pests of the crops rather as individual pests than as insects in themselves.

Yet, there are some ways, I believe, in which a greater uniformity of treatment can be obtained than we have at present, and for that reason I heartily approve of the suggestion which has just been made.

President Arthur Gibson suggested that the matter of standardization in teaching entomology be referred to the Committee on Policy, which has a sub-committee considering such subjects.

President Arthur Gibson: We will now listen to a paper by William Robinson.

WATER BINDING CAPACITY OF COLLOIDS A DEFINITE FACTOR IN WINTER HARDINESS OF INSECTS[1]

By Wm. Robinson, *Division of Entomology, University of Minnesota*

Abstract

Colloids present in insect tissues and body liquids withdraw and bind free water under a falling temperature. Some of the properties are changed when water is bound and this protects the insect during the winter. There is a direct correlation between winter hardiness of insects and amount of water bound.

An injurious species may be very numerous in the summer and autumn, and proportionately scarce in the following spring. This is common knowledge to entomologists. The low temperature of winter is an effective means of natural control. It functions in a two-fold way,

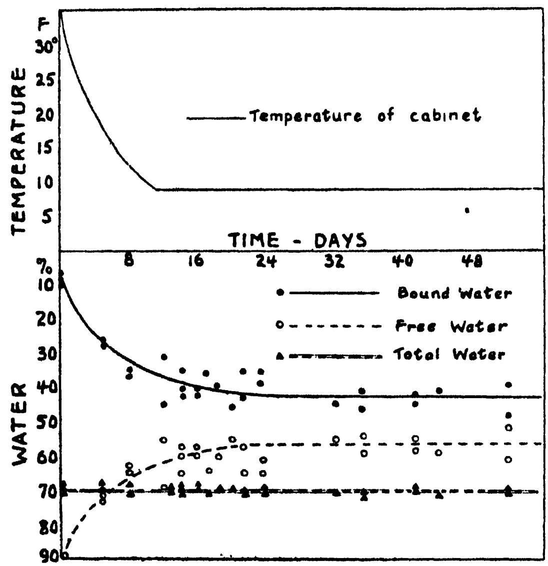


Fig. 1.—Effect of low temperature upon per cent of bound and free water with the moderately hardy *Callosamia promethea*.

for not only does it reduce the numbers of an injurious species year after year, even in an environment in which the species has become established, but it also restricts very largely the insect's continued spread. While their hosts go onward, the migration of many species of injurious insects is checked by the winter even when the summer is warm enough to per-

[1]Published with the approval of the director as paper No. 663 of the Journal series of the Minnesota Agricultural Experiment Station.

mit development of a life cycle. Why some species are unable to prepare themselves for certain low temperatures of winter and are thereby killed outright if so exposed, while others are able to survive, is a problem about which not much is known.

In the field of colloid chemistry, however, there appears to be at least a partial solution of the problem, in the activities of colloidal particles. Colloidal behavior depends upon the presence of exceedingly minute particles, one-tenth to one one-thousandth of a micron in size, which occur in stupendous numbers in the protoplasm and in the intercellular liquids. Under a falling temperature those particles which have an attraction for water (because of surface forces) will begin to adsorb the water in which they are dispersed. Under certain conditions they will adsorb also salts or ions from solution. That is, the particles will take

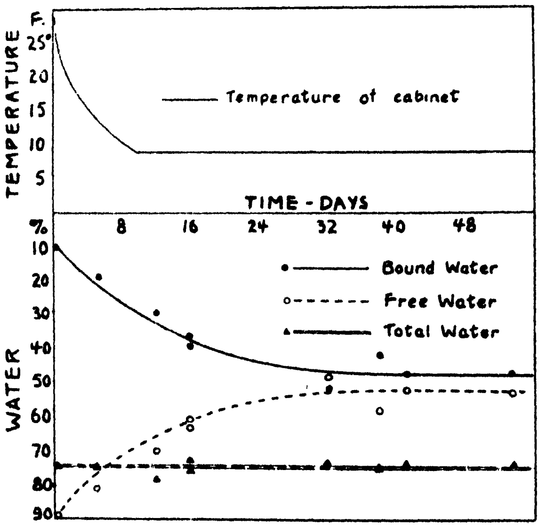


Fig. 2.—Effect of low temperature upon per cent of bound and free water with the hardy *Telea polyphemus.*

up water and bind it, not within but around themselves, as a film or shell. In this condition some of the properties of water are changed so that it ceases to function as ordinary free water. The shell may increase in thickness until it is greater than the diameter of the particle itself. Some of the innermost layers are held by the particle with a force that is almost inconceivable in biology.

There may be biological significance in the fact that some of the

properties of bound water are changed. There is not time here to discuss these except to mention that there is good evidence that bound water will not conduct electricity; will not freeze at five degrees below zero F. (—20°C.); will not dissolve sugars and other substances; and will undergo considerable compression. Free water is practically incompressible: the reason therefore that bound water can be compressed is, according to one theory, that it is oriented on the surfaces as layers of hydrogen and hydroxyl ions.

Newton and Gortner (1922), when working with hardy varieties of wheat, established the fact for plants that there is a direct correlation between winter hardiness and per cent of bound water; that is, the hardier the wheat the greater the amount of water the plant will bind at low temperatures. The writer is experimenting to determine if this phenomenon holds for animals, particularly cold blooded animals such as insects.

The hardy *Telea polyphemus*, the moderately hardy *Callosamia promethea*, and the non-hardy Granary Weevil, *Sitophilus granarius* were used for the preliminary tests. The pupae of the first two species are attached, within the cocoon, to the branches of the shrubs upon which the larvae feed, and are exposed to the lowest temperatures of winter in the regions where they occur. On the other hand, the Granary Weevils are rarely exposed to temperatures below 40°F. They cannot exist at 35°F. for more than a few days.

As the experiments progressed, it was seen that the phenomenon observed by Newton and Gortner for plants was holding true for insects. Under the stress of a falling temperature *polyphemus* and *promethea* began to gain in bound water and to lose in free water. The Granary Weevils, however, not only did not gain but actually lost bound water and gained in free water.

Low temperatures were obtained both naturally by placing some of the individuals outdoors during the autumn and winter and also artificially in refrigerating cabinets. Figures 1 and 2 show a fairly regular increase in bound water coincident with a fall in temperature. The cabinets were held at 8°F. which was just above the temperature which would cause the insects to freeze. Figures 3 and 4 show considerable fluctuations in temperature with a tendency for the bound water content to be similarly affected. *Promethea*, the moderately hardy species, lost bound water more quickly upon a rise in temperature than the hardier *polyphemus*. A scarcity of material at the time prevented more frequent determinations. Probably enough data are presented

to show fluctuations in per cent of bound water following changes in temperature.

In the non-hardy condition in which both species were started only 9% to 10% of bound water was found. This amount was increased during the experiment to approximately 42% for the moderately hardy *promethea* and to 48% to 52% for the hardier *polyphemus*. The latter species was able to bind more water and also to hold it more firmly

The total water content, it will be observed, remained practically constant throughout the experiments. The statement which is commonly made that the winter hardy condition is associated with low water content does not hold in this instance. However, winter hardiness is correlated with a low free water content; and possibly further studies will show this to be true in general.

The extent to which the non-hardy Granary Weevils reversed the process observed for the hardy species, is shown in Figure 5. In seven days at a temperature just below the freezing point of water, this species underwent a rapid degeneration in which it lost all but a mere fraction of its original bound water; and this was shortly followed by death.

Since bound water will not freeze at very low temperatures, the greater the quantity that can be converted into that form and the more rapidly it can be done, the greater is the protection afforded to that species. This is partly because of the expansion of water upon freezing and the consequent disruption of cells. There are other changes following freezing which time will not permit to discuss here. When adsorbed water undergoes compression, the colloidal particles and the bound water together occupy less space than the two separately. Therefore when free water freezes, as it does even in some hardy species, there will be more space for expansion without causing injury.

In making their determinations, Newton and Gortner used one hundred grams of wheat leaves and squeezed out the plant juice under a known pressure. In this way they established a correlation between pressure applied and amount of liquid expressed. This method, while suitable for plants, cannot very well be used for insects where a large mass of material is not available. The method used by the writer is based upon the fact that at —20°C. none of the bound water but all of the free water will be frozen; and also that as the free water freezes it will give off 80 calories of heat per cubic centimeter of volume. This heat is measured electrically with a potentiometer and thermocouple. The value for free water thus measured is subtracted from the total water content which is obtained by desiccation at 100°C., and the remainder is bound water. At this temperature all the bound water is not removed

and a higher drying temperature cannot safely be used, so that the bound water is a minimum determination.

During adsorption the body liquids of some species of insects become more concentrated. The lowering of the freezing point which occurs as a consequence is probably an advantage to those species, such as oak borers as noted by N. M. Payne (1926). However, depression of freezing

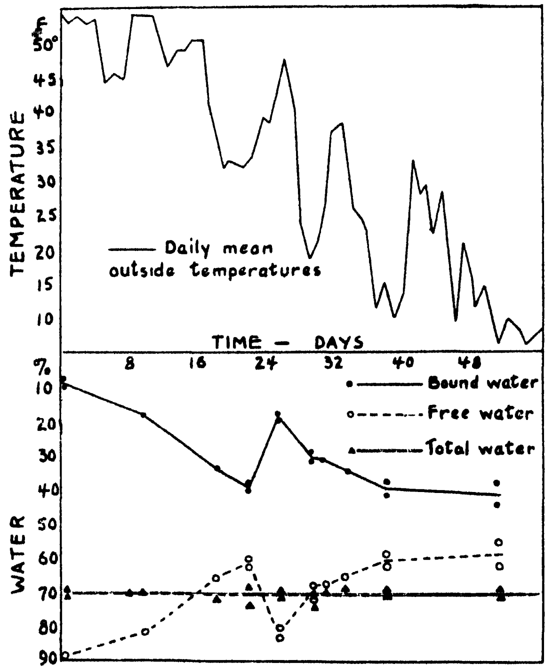


Fig. 3.—Effect of fluctuating outdoor temperatures upon per cent of bound and free water with the moderately hardy *Calloasmia promethea*.

point upon the approach of winter is apparently not as an essential factor in the hardening process and it does not always accompany adsorption. In the case of *polyphemus* and *promethea* used in the present experiments, the freezing point of the body liquids was not lowered, and remained at 27.5°F. (—2.5°C.) practically throughout the experiment, although 40% to 50% of the water was removed from solution. This is most likely due in part to the fact that under certain conditions adsorption will take up both water and salts, while under others the salts will be left in solution. If the electric charges on the colloidal particles and on the salts are similar they will repel each other, and adsorption of the

salts will be opposed. If the charges are dissimilar, the colloids and salts will be attracted and adsorption of the salts will be facilitated. Water and salts are adsorbed independently of each other and at different rates. Therefore depression of freezing point, when it occurs, does not necessarily indicate the extent to which hardening has progressed.

The tremendous force behind adsorption phenomena is derived from surface energy. Adsorption therefore is a physical process. Under a falling temperature a liquid with materials in solution or in suspension will become more viscous, as is well known. This alters interfacial

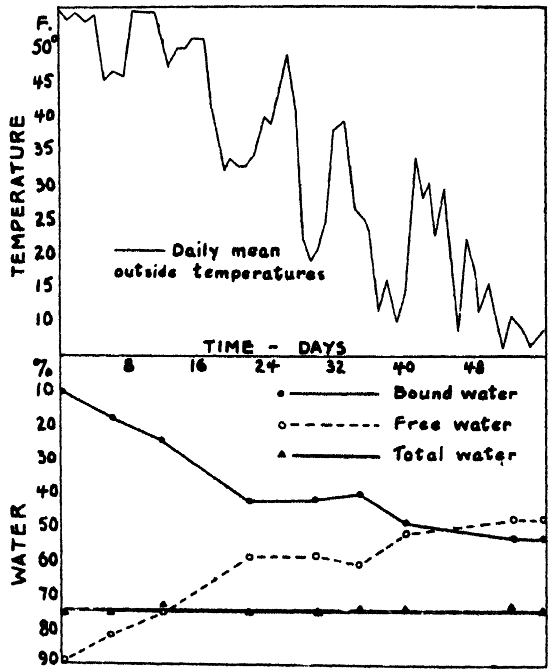


Fig. 4.—Effect of fluctuating outdoor temperatures upon per cent of bound and free water with the hardy *Telea polyphemus*.

tension between the colloidal particles and the liquid; and adsorption follows from the energy exerted to reduce this tension to a minimum. When equilibrium is established this activity will cease.

The per cent of water bound before equilibrium is reached is therefore an important phase of the problem of winter hardiness. For instance, with the hardy *polyphemus* this amount is between 48% and 52%, with the less hardy *promethea* it is between 40% and 42%, while with the

non-hardy Granary Weevils equilibrium was never reached. A rapid drop in bound water to practically nothing was terminated by death.

Accurate and complete data in low temperature studies are probably not obtained by determining the time and temperature necessary to kill an insect when it is exposed suddenly to any given low temperature. When an insect in the non-hardy summer condition is placed in a refrigerating cabinet representing winter conditions, that insect is exposed to an unnaturally abrupt change, and it may be killed before it can begin to protect itself. The study of winter hardiness may be extended to include:

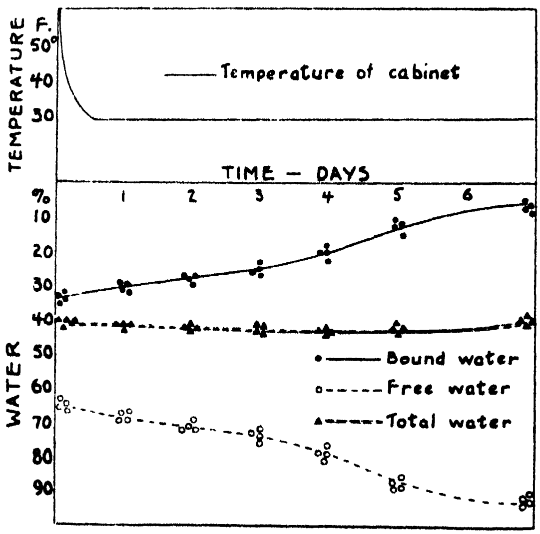


Fig. 5.—Showing reverse effect of a moderately low temperature upon the bound and free water content of the non-hardy *Sitophilus granarius*

1. Water Binding Capacity. This measures per cent of water adsorbed and shows how completely and quickly the species is able to protect itself, if at all, against the adverse conditions of winter. The temperature at which adsorption begins and when it reaches equilibrium should be determined, and the rate at different temperatures.

2. Water Holding Capacity. This measures the ability of the insect to retain its bound water during fluctuations in temperature, and is a very important factor in winter hardiness; for it is believed that rapid changes in temperature during the winter and early spring cause high mortality among some species of insects.

Any given species, when exposed normally to low temperatures, will probably react in a regular and definite manner according to the specific characteristics of its colloids. These vary considerably in different species. The size of the particles alone plays an exceedingly important role in surface phenomena. Species may have definite, inherent limitations beyond which they cannot go. Low temperature is not the only factor involved in limiting distribution. However, if the temperature encountered is lower than can be tolerated by the species, then, by Liebig's law of minimum, that is the limiting factor, no matter how favorable other factors may be. In other words, "the chain is no stronger than its weakest link."

Many species have not yet reached the outer boundary of their migration. If studies were made of a number of economic insects such as the European Corn Borer, the Japanese Beetle, the Alfalfa Weevil, etc., and a correlation observed between low temperatures on the one hand and water binding and water holding capacity on the other, it seems reasonable to assume that a measure of winter hardiness could be made and corresponding limitations placed upon the continued spread of these or any other species.

Summary

Colloidal particles which occur in protoplasm and intercellular liquids will adsorb free water under a falling temperature. The water thus bound ceases largely to function as ordinary free water.

The direct correlation between winter hardiness of wheat plants and per cent of bound water observed by Newton and Gortner (1922) has been found to hold for cold-blooded animals such as insects. When a hardy, a moderately hardy and a non-hardy species were tested, the per cent of water adsorbed was found to be in direct proportion to their winter hardiness.

The biological significance and the advantages to the species of having their free water changed into the bound form upon the approach of winter is discussed; and the method of making the determinations is described.

Depression of freezing point of body liquids does not always accompany the hardening process. This is due in part to the sign of the electric charges on the particles and on the salts in solution.

Adsorption is a physical process, and is due to energy exerted to reduce interfacial tension which is affected by low temperatures. When equilibrium is established adsorption will cease. Per cent of water bound

by the insect before equilibrium is reached is of importance in the hardening process.

Suggestion of including studies of water binding and water holding capacities in low temperature work is made.

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PRESIDENT ARTHUR GIBSON: The next paper is by F. L. Campbell.

NOTES ON SILKWORM NUTRITION

By F. L. CAMPBELL, *New York University*

ABSTRACT

Since nutritive liquids can be fed quantitatively to certain insects, it should be possible to determine the essential food components of an insect diet and their relative proportions. As a qualitative example of this method it is shown that cow's milk contains some food which the silkworm can utilize for maintenance. This method and the doubled leaf method described in this paper may also help to explain the specificity of food plants among leaf-eating insects.

Three possible explanations may be offered for the tendency of many leaf-eating insects to restrict their diet to the foliage of one or of a few species of plants: First, such an exact coadaptation may exist between the feeding mechanism of the insect and the acceptable foliage that it may be mechanically impossible for the insect to feed on leaves differing structurally from those of the chosen food plant. Second, the sense organs controlling the feeding mechanism may be so delicately adjusted to stimuli from the acceptable foliage that other leaves may not supply

stimuli requisite for setting the feeding mechanism in action; or, if the insect can attempt to eat, the repellent taste of the unusual foliage may prevent further feeding. Third, if foliage not normally consumed is eaten, it may lack the proper components for growth or maintenance, may not be sufficiently digested, or may even exert a toxic effect.

Some preliminary experiments were performed on the silkworm, *Bombyx mori*, to test the foregoing possibilities.

Since the silkworm in the latter instars feeds on the margin of the mulberry leaf, leaf thickness might be one of the physical factors limiting the food plants of this insect, the average thickness of the mulberry leaf being less than that of many other species. This possibility was tested by the following experiment: Two flat portions of a mulberry leaf were cut out, moistened with water, and pressed together. The interfacial film of water held the leaf portions firmly together during the time of the experiment. The edges of the doubled leaf were trimmed with scissors so as to leave a sharp, even margin. A number of these doubled leaves were prepared and were offered to fourth instar silkworms. The larvae consumed the leaves along the margin in the usual manner, proving in this case that double leaf thickness is not a barrier to feeding.

The doubled leaf method also offers an opportunity for testing the effect on feeding of stimuli from leaves. When one-half of the doubled leaf consists of mulberry and the other of a different species, the silkworm should eat both leaves simultaneously, if failure to eat the foreign leaf alone is due merely to the lack of the requisite stimuli from it. Ailanthus leaves, which have approximately the same thickness, surface, and flexibility as mulberry leaves, were used as the foreign member of the pair. The silkworms did not attempt to eat ailanthus leaves alone, but when ailanthus was combined with mulberry, the larvae did attack the double margin, being repelled at every attempt, apparently by the taste of ailanthus.

Since the silkworm will not eat many leaves, such as ailanthus, it is difficult if not impossible to test their food value. But one cannot help feeling that if it were possible to introduce foreign foliage into the alimentary tract, some of these species of leaves might maintain the life of the insect. If solids, such as leaf particles, cannot be introduced into the alimentary tract artificially, at least it is possible to introduce liquids. When a drop of an approximately neutral fluid is placed on the mouthparts of a silkworm, the drop is usually imbibed. The nutritive liquid most easily obtained is cow's milk. Consequently milk was used for the initial experiments, for it was thought that if a liquid so foreign to the nutrition of a phytophagous insect should prove adequate in any

degree for the maintenance of its life, one might hope to prepare a more suitable nutritive liquid.

The survival time of five milk-fed silkworms of the fourth instar was compared with that of starved controls. As much milk as a larva would take was administered at each feeding period, the worms being fed from two to six times a day. In about 24 hours after the beginning of the experiment the alimentary tract of the milk-fed worms was cleared of leaf fragments, and the worms appeared translucent when observed before a lamp. The excrement at this stage consisted of soft, curdy pellets of milk solids, showing that the intestinal juices had some effect on the milk. The larvae continued to drink milk freely and crawled about normally. Four days after the beginning of the experiment the starved controls were dead. The milk-fed worms were in good condition at this time, drinking avidly, passing milk-solid pellets, and crawling normally, but no growth had taken place for the worms had not gained weight,—nor had they lost weight. One week after the beginning of the experiment the milk-fed worms seemed slightly weaker and milk began to issue from the anus with the pellets; but the worms still drank avidly. The larvae lived three days longer becoming weaker and losing weight slightly but drinking milk to the last.

The milk-fed larvae lived a week longer than the starved controls. That this greater survival period was not due merely to dehydration of the controls was shown by a subsequent experiment in which the length of life of milk-fed worms was compared with that of water-fed controls. This experiment was continued only long enough to show that the milk-fed worms were in good condition after the water-fed worms had died.

These results seem to show that the silkworm can obtain some nutriment for maintenance from cow's milk. Further use of this method for studying insect nutrition might lead to a qualitative and even to a quantitative knowledge of food components essential for the growth and maintenance of certain insects, and incidentally might contribute to a better understanding of the reasons for the specificity of food plants among phytophagous insects.

MR. N. E. McINDOO: If he wanted those silkworms to eat those apple leaves, he could have fooled them by dipping them in the juice of the mulberry leaves. We carried on a number of experiments, using apple leaves, peach leaves and plum leaves, and several others. It was very easy to get the silkworms to eat the leaves that they don't ordinarily eat, by wetting them in the mulberry juice.

PRESIDENT ARTHUR GIBSON: The next is a paper by Miss Grace H. Griswold.

OBSERVATIONS ON THE BIOLOGY OF A NEW GERANIUM APHID (*MACROSIPHUM CORNELLI* PATCH)

By GRACE H. GRISWOLD, *Cornell University*

ABSTRACT

The host plants of the aphid, the number of instars, the length of the reproductive period and the number of young produced are discussed. Notes are given on the habits of four hymenopterous parasites reared from the aphid, namely, a braconid, *Praon simulans* and three chalcids, *Aphelinus jucundus*, *A. semiflavus* and *Aphidencyrtus inquisitor*. Control measures are suggested.

During the spring of 1925 a geranium which was badly infested with aphids was brought to the Insectary. Specimens of the insects were sent to Dr. Edith M. Patch for identification. She found them to be closely related to the European geranium aphid, *Macrosiphum pelargonii* (Kalt.). They differ from this species, however, in the number of sensoria on the third antennal segment of the wingless female. Dr. Patch has therefore (1926: 334) described them as a new species under the name *Macrosiphum cornelli*. According to Theobald (1926: 125) in *Macrosiphum pelargonii* the sensoria on III of the antenna of the wingless female range from 1 to 5, whereas in *Macrosiphum cornelli* they average many more, about 15 generally.

HOST PLANTS. This aphid has as its host plants in the greenhouse several species of the genus Pelargonium. Although the insect has been in the greenhouse constantly in great numbers during the past twenty months it has never been found attacking any other genus of plants. In the list of geraniums here given[1] the species are arranged in accordance with what seems to be the preference of the aphid: *Pelargonium quercifolium* hybrid, *P. odoratissimum*, *P. domesticum*, *P. graveolens*, *P. peltatum* and *P. radula*.

Plants of the commonest of all geraniums, *Pelargonium hortorum* have always been in the greenhouse but the aphids have never been found to feed upon them.

FEEDING HABITS. The aphids are found principally on the under surface of the leaves where they feed along the midrib and other large veins. They also cluster on the petioles and on the stems of new growth.

LIFE HISTORY. During the time that it has been under observation the aphid has reproduced only parthenogenetically and no sexual

[1]Determined through the courtesy of Lua A. Minns of the Department of Floriculture and Ornamental Horticulture at Cornell University.

forms have been found. Females give birth to living young at all times of year. Life history studies show that there are four molts and therefore five instars. Under ordinary greenhouse conditions of temperature and humidity the aphid begins to produce young within about twenty-four hours after becoming adult. The main reproductive period lasts about two weeks but may be extended considerably. The number of young produced each day is reduced, however, and often several days may elapse without any being born. Then the female may give birth to a single individual and again two or three days will pass. This sort of thing may go on for a week or two. Finally reproduction stops entirely but the aphid may continue to live for some time. In one instance in the present study an individual lived 22 days after reproduction had ceased. The entire life of this particular aphid extended over a period of 59 days, which was slightly longer than that of any of the other aphids under observation.

Because of a shortage of host material it was not possible to rear many aphids on individual plants. Some other method, therefore, had to be devised. Geranium leaves will keep fresh for days in water and on leaves so kept it was possible to rear a long series of insects in individual cages. Aphids so reared never lacked for moisture and often remained for days apparently in exactly the same spot on the leaf. It was found, however, that aphids reared in this manner matured more rapidly and seem to have produced a larger number of young than did those that developed on growing plants. Insects reared on leaves in water matured in from 9 to 11 days while those that developed on growing plants required from 11 to 13 days. The maximum number of young produced by 29 aphids kept on leaves in water was 80, the minimum 8, and the average 35.65. So few aphids were reared on growing plants through their entire reproductive period that it is not possible to make accurate comparisons. The maximum number of young produced by 9 individuals so reared was 34, the minimum 4, and the average 21.88. It is planned to propagate sufficient material so that it will be possible to conduct further rearing experiments on growing plants. In this way additional data can be obtained under what are probably more normal conditions for the insect.

PARASITES. In the present study four species of hymenopterous parasites[2] have been reared from this aphid:—the braconid *Praon simulans* Prov. and three chalcids; *Aphelinus jucundus* Gahan, *Aphelinus semiflavus* How. and *Aphidencyrtus inquisitor* (How.).

[2]Determined through the courtesy of A. B. Gahan of the U. S. Bureau of Entomology.

Praon simulans, when its larval growth is practically complete, leaves the aphid through a slit cut in its ventral surface (Wheeler 1923: 25). It then spins a cocoon beneath the body of its host, thus raising the whitened shell of the aphid from the plant surface. In this cocoon pupation of the parasite takes place.

Aphelinus jucundus was probably brought into the Insectary greenhouse with the aphid for this parasite has been constantly present ever since and hundreds of specimens have been reared. This chalcid is evidently parthenogenetic for no males have yet been encountered. Life history studies now going on show it to be a primary parasite and that the life cycle requires about four weeks. When the larva of the Aphelinus has attained its growth and its feces have been voided, the aphid turns black and within this blackened shell pupation of the parasite occurs.

Aphelinus semiflavus is probably also a primary parasite. The biology of this chalcid was carefully studied by Hartley (1922: 209–236).

Aphidencyrtus inquisitor, on the other hand, appears to be a hyperparasite, though the final proof of this is still lacking. Large numbers of geranium aphids from which this parasite has been reared have been dissected. In every case some evidence of other occupancy of the host has been found. In a few instances actual remains of *Aphelinus jucundus* pupae or adults have been present, but generally the principal evidence has consisted in the finding of two kinds of feces. Dissection of geranium aphids from which specimens of *Aphelinus jucundus* have emerged show the excrement to be in the form of flat black plates. In aphids from which the Aphidencyrtus has emerged, however, are found not only these same flat black plates, but also small orange-colored pellets of excrement.

Rearing experiments were attempted to prove the point. Several specimens of both sexes of this parasite were introduced into a cage of parasite free aphids but without success. At the same time and in exactly the same manner specimens of the Aphelinus were introduced into a cage of parasite free aphids. About a month later large numbers of these chalcids emerged. During February, 1926, the Aphidencyrtus suddenly disappeared from the greenhouse and not a specimen has appeared there since. A short time ago several individuals of both sexes were reared from aphids taken in the greenhouse of the Department of Plant Breeding. These were allowed to mate and were then liberated at the Insectary. It is hoped that they will again become established. Dr. L. O. Howard has suggested the advisability of dissecting living

material to definitely settle the question of hyperparasitism. If sufficient individuals become available this will be done.

Control

In a greenhouse the geranium aphid can be easily controlled by fumigation with calcium cyanide using ¼ ounce to every 1,000 cubic feet of space.

Where fumigation is not feasible nicotine sulfate may be used at the rate of 1 teaspoonful to 1 gallon of water. To this 1 ounce of ivory soap should be added. This material may be applied as a spray or the plants may be dipped in it.

Probably the simplest method of control other than fumigation is the use of a 2% free nicotine dust. Within five minutes after the dust has been applied aphids may be seen dropping from the plants. Experiments at the Insectary have shown that from 90 to 100 per cent control can be secured by the use of this dust.

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President Arthur Gibson: The next paper is by Miss Bessie M. Broadbent.

FURTHER OBSERVATIONS ON THE LIFE HISTORY, HABITS, AND CONTROL OF THE NARCISSUS BULB FLY, *MERODON EQUESTRIS*, WITH DATA ON THE EFFECTS OF CARBON DISULPHIDE FUMIGATION ON THREE BULB PESTS

By Miss B. M. Broadbent, *Junior Entomologist, U. S. Bureau of Entomology, Washington, D. C.*

Abstract

Since November 1925, considerable progress has been made in working out details of the biology of the Narcissus bulb fly, *Merodon equestris* Fab., under outdoor conditions at Washington, D. C. It was found that the larval stage lasted about 10 months. Pupation took place from March 25 to April 17, 1926, and the pupal stage lasted 5 to 7 weeks. Flies emerged from May 8 to 22. Maximum longevity of the flies was 4 weeks, the average length of life being 16 or 17 days. Egg laying capacity was nearly 100 eggs per female fly. Eggs hatched in 10 to 14 days, the average

being 12. Larvae grew most rapidly during the first two months. Detailed information on various phases of the life history is presented in tabular form. Notes showing severity of infestation of imported King Alfred narcissus bulbs with larvae of *M. equestris*, *E. strigatus*, and *R. hyacinthi* are given.

Preliminary data is presented in tabular form showing the effects of CS_2 fumigation, under normal atmospheric pressure, on larvae of both bulb flies and on the bulb mite, as well as on the subsequent growth and flowering of the bulbs at dosages ranging from 10 to 30 pounds per 1000 cu. ft. with exposures lasting 2, 12, and 23½ hours. The results proved quite decisive and serve to suggest the range of effectiveness of this chemical as a bulb fumigant. The 10 lb. dosage with a 2 hr. exposure was equally ineffective under a 27-inch vacuum and under normal atmospheric pressure, but neither treatment injured the growth and flowering of the bulbs as compared with that of the untreated "checks." Dosages of from 10 to 30 lbs. with exposures of 23½ hrs. gave 100 per cent control of both species of larvae and from 90 to 99.4 per cent control of the bulb mites. Dosages of 20 to 30 lbs. with a 23½ hr. exposure proved fatal to the bulbs and caused a characteristic brownish discoloration of the basal plate. These results suggest the possibility of finding a range of lower dosages and shorter exposures that will kill these pests without injuring the bulbs.

In an effort to furnish more definite information about the life history, habits, and control of the Narcissus bulb fly, *Merodon equestris* Fab., under American conditions than was already available in literature, the Bureau of Entomology during the summer of 1924 undertook to make a study of this insect. Owing to the limited supply of infested bulbs that was available for this purpose, it was impossible at that time to do more than work out a satisfactory method of rearing the flies, and to make general observations on their seasonal life history and habits. These preliminary observations were published by Dr. C. A. Weigel.[1]

The Narcissus bulb quarantine which became effective on January 1, 1926, has tended to compel recognition of the importance of preventing the permanent establishment of this bulb fly in commercial bulb plantings, and has emphasized the need for more accurate information about its behavior. For these reasons the Bureau has not only established a Bulb Insects Field Station at Santa Cruz, California, in charge of C. F. Doucette, who is investigating this problem under the climatic conditions that prevail in the Pacific Coast bulb plantings, but has also continued the investigations which were being made under eastern conditions at Washington, D. C.

During the past year the writer, under the direction of Dr. Weigel, and with the assistance of A. T. Grimes, attempted to work out in

[1]Weigel, C. A. Observations on the life history of the Narcissus or Daffodil fly, *Merodon equestris* Fab. Journal of Economic Entomology, Vol. 19, No. 3, pp. 497–501. June, 1926.

more detail various phases of the life history of the bulb fly under outdoor conditions in the East. The results of these studies, together with the experiments with carbon disulphide fumigation for the control of both bulb flies and the bulb mites, which are discussed under "Control," are presented herein. The purpose of this paper is primarily to make this information available to other investigators in the same field. Technical descriptions of the various stages are purposely omitted, and for the sake of brevity much of the data recorded from different observations is presented in tabular form. The life history records are discussed in chronological order to avoid confusing the development of different broods of the flies.

Source of Larval Specimens. In November 1925, many nearly full-grown larvae from two different sources were available to continue this investigation. One lot consisted of a few larvae reared from stock obtained from the Pacific Coast in August 1924 that had previously been used in the life history studies during 1925. The other and principal source of larval material was a supply of heavily infested King Alfred Narcissus bulbs selected from a shipment that had recently been imported from Holland, and was submitted to this office for experimental use.

The reared larvae were infesting bulbs planted in bulb pans sunk in sand in large screened boxes in the cold frame, and were left undisturbed until the adult flies had emerged from them the following spring. A total of 19 flies emerged from this material between the dates of May 8 and 22, 1926. Most of the bulbs from Holland that were infested by *Merodon* larvae were used in the carbon disulphide fumigation experiments. Enough were salvaged, however, so that it was possible to rear more than 100 flies from them.

Rearing Methods. The rearing methods used were very similar to those used the previous year. Pans or flats containing bulbs infested with the *Merodon* larvae were left undisturbed in a cold frame over winter, i. e., from December until March 25, where they were covered by a layer of ashes several inches deep to protect them from extreme cold.

In the spring these flats were uncovered and then screened to prevent the possible escape of flies. From the middle of March until late in April these infested bulbs were examined daily to determine the exact date when pupation took place. The pupae were removed and placed near the surface of the soil in small pots. These pots were then sunk in boxes of sand to keep them from drying out too much. The boxes were then screened, and placed in a screen insectary, 9′ x 6′ x 6′, located near

the greenhouse. As soon as these flies emerged, they were released in insect cages measuring 12″ x 19″ x 21″ which had screen on five sides, and were mounted on oil cups to keep the small red ant, *Monomorium pharaonis* L., from attacking the flies. Pots of bulbs exposed to egg laying by these flies were removed daily, or more often if necessary, in order to get the exact dates of oviposition. After the larvae had hatched from these eggs, the pots of bulbs were then sunk in boxes of sand in the cold frame and were examined at intervals during the summer to get data on larval development. Since these specimens were reared entirely under outdoor conditions, it is believed that they approximate fairly closely the development of the flies under climatic conditions that are likely to prevail in the Eastern bulb plantings.

SEASONAL HISTORY. Briefly outlined, the seasonal history of the fly from May 1925 to November 1926 has been as follows: Eggs were deposited during the latter part of May and early in June from which larvae hatched and began feeding in June. These larvae continued to feed in the bulbs for many months, and remained in them as larvae during the winter. None of them transformed to pupae earlier than March 25, 1926, after spending approximately ten months in the larval stage. The pupal period lasted for from five to seven weeks, and averaged about six weeks. The flies began to emerge on May 8, and continued to appear daily until May 20, thus completing a one-year life cycle of development from egg to adult.

These flies laid eggs from May 14 to June 7, from which larvae hatched within two weeks, or during the latter part of May and early in June. These larvae still remain in the bulbs in November, although some of them are now about six months old and appear to be full grown.

The evidence thus far obtained seems to indicate that this species is able to survive the winter under outdoor conditions in the East and breed continuously from year to year.

LIFE HISTORY AND HABITS

LARVAL PERIOD. The larval period lasted about ten months according to the records obtained from larvae that hatched from eggs laid late in May 1925. These newly hatched larvae began feeding in the bulbs early in June, and continued to feed during the summer. They remained in the bulbs all winter without changing to pupae, and in fact they did not begin to pupate earlier than March 25, 1926. That most of them had already pupated by April 10, however, is shown by the following records:

57 larvae pupated from March 25 to 31;

41 pupated from April 1 to 10; and
8 pupated from April 11 to 17.

PUPAL PERIOD. The pupal period during the spring of 1926 was found to vary from 33 to 50 days, based on exact records for 66 individuals, and these observations are presented in Table 1. The average time was about 43 days, and the dates of pupation ranged from March 25 to April 17. The duration of the pupal stage was evidently determined mainly by the prevailing temperatures. For example, the longest period noted was from March 26 to May 15, and the shortest was from April 15 to May 18, the time decreasing as the weather grew warmer. Two flies that had pupated on April 9 and 17 respectively, emerged on the same day, May 20, a difference of eight days. The mean soil temperature during the interval from March 30 to April 30, inclusive, was 52.5° F., the maximum being 67° and the minimum 43°.

The pupa usually occupies a nearly vertical or somewhat slanting position with its head about level with the surface of the soil so that it is in contact with the air. In one instance it happened that a pupa was buried deeper, and the fly successfully emerged through about half an inch of soil. Several other pupae that were intentionally buried under a layer of soil 3 inches deep, failed to get out of their pupal shells and died there without emerging or reaching the surface. One pupa in a flat that was not disturbed from November 1925, until May 27, 1926, was found beneath the surface where it had pupated. Its respiratory cornua had failed to push through the puparium, and it had failed to develop into a fly.

Most of the larval specimens under observation had to be disturbed frequently during March and April to find out when they were ready to pupate. As a check on the seasonal development of the flies under normal field conditions three flats, each of which contained about 20 infested bulbs, were left undisturbed from December until May 20. The flies began to emerge from them on May 10, and on May 20 when the bulbs were cut up, and the soil sifted, a total of 32 flies had emerged. About 10 pupae failed to emerge and three of them were dead or decayed. These results indicate that there was no significant difference in the date of emergence of the flies when the larvae had been disturbed frequently, and when they had not been disturbed at all.

The pair of anterior respiratory cornua which appear on the pupal head were not observed to push through the wall of the puparium and become visible externally until from 9 to 14 days after the larva had pupated. (These observations are presented in Table 2.) These

TABLE 1. DURATION OF PUPAL PERIOD OF *Merodon equestris* IN 1926, BASED ON DEFINITE RECORDS FOR 66 INDIVIDUALS, SHOWING HOUR OF EMERGENCE OF FLIES

Number of Flies		Date of		Hour of	Duration of
Female	Male	Pupation 1926	Emergence 1926	emergence A. M.	pupal period Days
1		Apr. 15	May 18	7:25	33
	1	17	20	12:20*	33
1		15	19	7:00	34
1	2	1	9	8:00	39
2		8	17	7:35	39
	1	9	18	7:25	39
1	1	1	10	8:00	40
1	1	5	15	7:40	40
	2	8	18	7:45	40
	1	1	12	8:45	41
	1	2	13	9:15	41
1		4	15	7:35	41
1	1	6	17	6:40	41
1	1	6	17	7:25	41
1		8	19	9:30	41
1		9	20	7:40	41
2		4	16	3:00*	42
1	1	6	18	7:25	42
	1	Mar. 29	11	10:00	43
1		Apr. 1	14	8:00	43
1		4	17	7:00	43
2		4	17	8:05	43
1		5	18	4:00*	43
1		Mar. 27	10	8:15	44
1		29	12	7:45	44
	1	29	12	10:30	44
1	1	Apr. 4	18	7:10	44
1		Mar. 27	11	8:00	45
	1	27	11	10:45	45
1	2	29	13	7:50	45
1	1	30	14	8:50	45
1		27	12	7:45	46
2		29	14	7:45	46
2	1	29	14	8:40	46
	1	30	15	7:35	46
1	1	27	13	7:50	47
	1	29	15	7:30	47
	1	25	12	8:15	48
2	1	27	14	7:45	48
1		27	14	9:10	48
2		27	15	7:50	49
1		27	15	11:45	49
2		26	15	7:35	50

*p. m.

cornua remain attached to the inner membrane lining the puparium even after the fly has emerged.

A pupa that had transformed on April 4, was examined 10 days later by cutting away its pupal shell. It appeared as a white, grublike, rather soft, shapeless mass. Its head, legs and wings were only slightly developed, and the anterior respiratory cornua just mentioned were short and close together, and had not yet pushed through the outer shell. The cornua appeared reddish brown when they first became visible but soon turned darker.

Another pupa was examined on April 27 which was further advanced in its development. Its body appeared plump, white and grublike and its partly developed wings and legs were folded so that they fitted together along the depression between the head and abdomen. Its eyes appeared orange colored with darker brownish patches near the centre. The respiratory cornua projected through two round holes in the caplike anterior end of the puparium.

TABLE 2. INTERVAL AFTER PUPATION BEFORE FIRST EXTERNAL APPEARANCE OF ANTERIOR RESPIRATORY CORNUA ON PUPAE OF *Merodon equestris*

No. of pupae	Date of pupation	Date of first appearance of respiratory cornua	Time	Remarks
	1926	1926	Days	
1	Apr. 15	Apr. 24	9	at 12:30 p. m
1	17	26	9	
2	15	25	10	
2	13	24	11	at 8:15 a. m.
7	8	22	14	

EMERGENCE. Observations indicate that the fly requires very little time for forcing its way out of the puparium. In spite of almost constant observation of perhaps a hundred pupae, the flies were usually ready to tumble out before their activity attracted attention. In fact this act was accomplished so speedily that in only two instances was it actually seen. In each case not more than a minute elapsed before the fly had succeeded in freeing itself from the puparium and making its escape. (See Table 3.)

The fly after emerging usually climbed some support, such as the bulb foliage or the wooden label in the pot, where it would be exposed to the air. Its wings appeared rather damp and crumpled at first, and did not become fully spread until from 10 to 39 minutes later. The interval from emergence until the spread wings relaxed and became folded along the back varied from 35 to 60 minutes. Some individuals were observed to use their wings for flight as early as 10:30 a. m., the same

day they emerged. Ordinarily flight was not attempted for several hours after emergence, even though the wings appeared normal after one hour.

The following records indicate that the flies normally emerge early in the morning and that about seven out of every eight flies emerge before noon:

80 flies emerged between 6:00 a. m., and 9:00 a. m.
25 emerged between 9:00 a. m. and 12:00 m., and
15 between 12:00 m. and 5:00 p. m.

Moreover it was found that a number of those emerging after noon were quite obviously delayed by low temperatures, and by rain which had fallen overnight and during the forenoon. These observations, together with records already presented in Table 1, show that a few individuals had actually emerged before 6:40 a. m.

TABLE 3. TIME REQUIRED FOR EMERGENCE OF *Merodon equestris* FLIES UNTIL THE WINGS ARE FOLDED

Sex of fly	Date of emergence 1926	Head of fly out of puparium at a. m.	Fly free from puparium a. m.	Time for emergence Minutes	Wings fully spread a. m.	Time for expanding wings Minutes	Wings folded at a. m.	Total time elapsed Minutes
Male	May 17	7:44	7:45	1	8:23	38	—	—
Female	17	8:51	8:52	1	9:10	18	9:52	60
Male	17	—	8:55	—	9:13	18	9:35	40
Female	18	—	7:25	—	7:50	25	8:15	50
Male	18	—	7:45	—	7:55	10	8:20	35
Female	17	—	8:05	—	8:44	39	—	—
Female	17	—	9:55	—	10:05	10	—	—
Male	19	—	7:43	—	8:05	22	—	—

FEEDING. The flies were kept confined in screened insect cages in the outdoor screened insectary already mentioned under "rearing methods," and were fed daily by smearing a few drops of extracted honey on the screen tops of their cages where they could lap it up. They fed freely on bright clear days, but remained inactive and did not eat when the weather was cold, dark, or rainy.

Drinking water was provided each morning by placing on the floor of the cage a shallow watch glass which contained a film of water not more than one-fourth inch deep, in order to keep the flies from getting too wet by falling in it.

The Narcissus fly because of its size is sometimes referred to as the greater bulb fly to distinguish it from the lesser bulb fly, *Eumerus strigatus* Fallen. It resembles a bumblebee to some extent not only in

its size and coloring but also in its actions. It is stout-bodied, and about half an inch long. Its body color is usually shining black, ornamented with short, yellowish and black hairs arranged in such a manner that it often appears to have a black band across either or both the thorax and abdomen. The color pattern is, however, extremely variable. One entirely black female fly with dark wings was reared last spring, and there are occasional yellow individuals.

The fly gives a very clever imitation of a bee by humming and buzzing or hovering over flowers. It was noted that they were strongly attracted to the blooms of roses, especially the variety "Silver Moon," but gave little attention to such nectar bearing flowers as honeysuckle, columbine, and mock orange blooms.

PROPORTION OF SEXES. The proportion of sexes as based on records for 120 flies that emerged during May 1926, indicates a ratio of about 122 females to every 100 males. The eyes of the male flies are set close together, but are distinctly separated in the females.

MATING. The duration of copulation as observed on May 14 and 15 varied from 3 to 11 minutes, and the air temperatures associated with this activity ranged from 64 to 84° F. (see Table 4). Mating took

TABLE 4. DURATION OF COPULATION OF *Merodon equestris* FLIES

Date	Time of copulation		Duration of copulation	Air temperature
	Beginning	End		
1926	a. m.	a. m.	Minutes	°F.
May 14	8:20	8:27	7	66
14	8:20	8:26	6	66
15	8:35	8:40	5	75
15	8:15	8:21	6	74
15	8:40	8:48	8	75
15	9:00	9:11	11	76
15	9:04	9:10	6	76
15	10:15	10:21	6	78
15	10:22	10:27	5	79
15	10:26	10:32	6	79
15	10:30	10:37	7	81
15	10:26	10:33	7	80
15	10:40	10:46	6	82
15	11:05	11:11	6	82
17	8:10	8:20	10	64
	p. m.	p. m.		
14	12:31	12:34	3	78
14	1:02	1:07	5	78
15	12:00	12:05	5	82
15	1:30	1:35	5	84
15	1:45	1:48	3	84
15	2:45	2:50	5	84
15	3:00	3:04	4	84

place most frequently during the forenoon, and in bright sunlight. The earliest hour noted was 8:20 a. m. and the latest 3:04 p. m. Of the 73 observations made, 53 instances of mating were noted during the morning hours and only 20 in the afternoon.

Oviposition. In order to get data on the number of eggs laid by individual flies, 3 were isolated in lantern globe cages immediately after mating, and kept under daily observation until death. They had emerged on May 15; mated on May 17; and two began egg laying on May 19 at the same hour. One fly died without depositing any eggs, and a total of 93 eggs were found inside her body. Two of these flies laid their eggs at irregular intervals, as indicated in Table 5. The totals of deposited and undeposited eggs for these individuals were 97 and 96 eggs respectively. This indicates a capacity of approximately a hundred eggs per fly. One fly that was dissected immediately after emergence contained more than ninety eggs as small round white discs.

Table 5. Number of Eggs from Three *Merodon equestris* Flies that Emerged on May 15, and were Isolated in Lantern Globe Cages Immediately after they had Mated on May 17, 1926

Hour of mating A.M.	First oviposition Hour P.M.	First oviposition Date 1926	Number of eggs laid per day during May 19	20	21	22	23	24	25	26	27	28	29	30	31	June 1	2	3	4	Date of death 1926	Total no. eggs Laid	Total no. eggs Not deposited	Total eggs per fly
9:20	—	—	0	0	0	0	0	0	0	0	-		-	-	-	-	-	-	-	5/27	0	93	93
9.30	2·40	5/19	27	0	0	0	0	0	0	53	0	0	3	0	0	0	0	-	-	6/3	83	14	97
10·10	2.40	5/19	22	2	15	10	0	5	1	6	0	0	0	13	0	0	0	0		6/4	74	22	96

No less than 1,248 eggs were deposited by the 66 female flies that were under observation. Twenty-four of these flies were dissected after death, and were found to have retained about 535 undeposited eggs. A number of flies that had lived for from 18 to 28 days deposited all their eggs even under cage conditions, and it seems reasonable to assume that flies having unrestricted choice of the bulbs in a field might deposit nearly all their eggs.

It appeared to make little difference whether one or one hundred eggs were deposited on a bulb, for in most instances only one larva developed successfully in it. As many as seven very young larvae were found in one bulb during the summer, but only two bulbs out of more than a hundred that were examined on November 10 contained two larvae.

It seems probable that in some instances eggs were infertile, for it was noted that the eggs deposited by one individual failed to hatch and when broken gave no evidence of embryonic development.

Oviposition took place only during the day, the earliest record being 8:45 a. m., and occurred most frequently in the afternoon between two

and four o'clock. The following records indicate that after noon is the favorite time for egg laying:

May 19.— 60 eggs were laid between 7:30 a. m. and 11:15 a. m
45 between 11:15 a. m. and 2:00 p. m.; and
100 after 2:00 p. m.

May 21.— 18 eggs were laid in the forenoon and
100 in the afternoon.

Eggs were rarely laid on cold, cloudy or rainy days. For example, no eggs were deposited on May 16 which was a rainy Sunday with an air temperature of about 57° F. June 6, likewise, was a dark cloudy day with a temperature of 62° F., and no eggs were laid.

When ready to lay, the female fly was observed to seek a suitable place for her eggs by crawling about with her ovipositor extended and curved downward in contact with the soil or bulbs. After finding a crevice in the soil or a space between the sheath and stem, or between the layers of skin enclosing the neck of such bulbs as amaryllis, narcissus or onion, the fly inserts her ovipositor and places one or more eggs so that they are usually hidden from sight. She remains near the bulbs for from 2 to 5 minutes before flying away. (See Table 6.) Just after deposition the eggs can easily be found by examining the exposed crown of the bulb, but a few days later rain or water may have washed them out of sight so that it may be practically impossible to locate them again.

Eggs were laid singly or groups of two or three but sometimes more were grouped together. For example, as many as 11 eggs were counted in a single cluster; 7 was a frequent number; and 8 occurred once. An isolated female laid 5 eggs in a single cluster, and as many as 53 on one bulb the same day.

TABLE 6.—TIME SPENT BY *Merodon equestris* FLIES IN OVIPOSITING

Date	Time of oviposition		Time spent near bulb
	Began	Flew away	
1926	p. m.	p. m.	Minutes
May 15	12:00	12:05	5
15	1:50	1:54	4
15	3:05	3:07	2
15	3:07	3:11	4
15	3:25	3:30	5
21	2:55	2:58	3
17	11:20*	11:23	3
17	11:20*	11:25	5

*a. m.

PREOVIPOSITION PERIOD. The interval of time from the date of emergence to the first egg laying, as based on records for seven flies, varied from 2 to 6 days. (See Table 7.) It was also found that egg deposition began from 2 to 4 days after mating had taken place.

TABLE 7. PREOVIPOSITION RECORDS FOR SEVEN *Merodon equestris* FLIES

Fly No.	Date of emergence 1926	Date of mating 1926	Date of first oviposition 1926	Duration of preoviposition period Days
1	May 9	May 11	May 15	6
2	10	11	15	5
3	15	17	19	4
4	15	17	19	4
5	15	17	19	4
6	17	18	20	3
7	18	19	20	2

POSTOVIPOSITION PERIOD. Records for five individuals shown in Table 8 indicate that a postoviposition period of from 2 to 4 days may intervene between the date of final egg laying and the death of the fly.

TABLE 8. POSTOVIPOSITION RECORDS FOR FIVE *Merodon equestris* FLIES THAT EMERGED ON MAY 15, 1926

Fly No.	Date of last oviposition 1926	Date of death 1926	Duration of postoviposition period Days
1	May 29	June 2	4
2	29	1	3
3	30	3	4
4	31	2	2
5	June 10	14	4

LONGEVITY. The length of life of 52 male flies was found to vary from 1 to 25 days with an average of nearly 17 days. (See Table 9). Records for 54 female flies gave an average of about 16 days, and a range in longevity of from 3 to 28 days. (See Table 10). It was noted that 42 per cent of the flies lived 20 days or longer.

Under cage condition the flies injured their wings, or in some instances broke them off entirely, by flying against the screen with their wings in full vibration. This injury sometimes prevented flight, and caused some eggs to be laid on the floor of the cages, but did not appear to be serious for the flies could still crawl, and were able to continue their usual activities of feeding, mating and ovipositing. In general, the flies appear rather sturdy and are not easily killed.

TABLE 9. LONGEVITY RECORDS FOR 52 MALE *Merodon equestris* FLIES

No. of flies	Date of Emergence 1926	Date of Death 1926	Length of life Days
1	May 18	May 19	1
4	15	19	4
3	17	25	8
1	18	27	9
1	18	28	10
1	15	26	11
1	17	29	12
1	18	30	12
1	17	30	13
1	18	31	13
1	22	June 4	13
2	9	May 23	14
1	9	25	16
2	10	27	17
2	11	28	17
1	11	29	18
1	17	June 4	18
2	12	May 31	19
1	12	June 1	20
4	15	4	20
1	18	7	20
1	19	8	20
2	13	3	21
3	12	3	22
3	13	4	22
2	13	5	23
1	15	7	23
5	14	7	24
1	15	9	25
1	16	10	25

INCUBATION PERIOD. In 1926, during May and early in June, eggs hatched in from 10 to 14 days. (See Table 11). The average time required appeared to be about 12 days. The air temperatures during this period varied for the most part between 60° and 80° F., and it is believed that these rather low temperatures may have increased the time needed for incubation this spring.

When ready to emerge the larva chews or tears an irregular hole in the egg shell near one end and crawls out.

SIZE OF LARVA. The following figures indicate the maximum size of larvae found at varying ages:

Newly hatched	1.5 mm. long by 1.5 mm. wide
5 days old	2.5 mm. long by 0.75 mm. wide

1 month old	6.0 mm. long by 2.0 mm. wide
2 months old	13.0 mm. long by 4.0 mm. wide
3 months old	15.0 mm. long by 5.0 mm. wide
5 months old	15.0 mm. long by 5.0 mm. wide
160 days old	17.0 mm. long by 6.0 mm. wide

TABLE 10. LONGEVITY RECORDS FOR 54 FEMALE *Merodon equestris* FLIES

No. of flies	Date of Emergence 1926	Date of Death 1926	Length of life Days
1	May 17	May 20	3
1	17	21	4
1	18	22	4
1	15	20	5
1	18	24	6
1	9	16	7
1	10	17	7
1	10	18	8
1	17	25	8
1	18	26	8
2	10	19	9
1	18	27	9
4	15	25	10
1	18	28	10
1	10	21	11
1	15	27	12
1	18	30	12
1	10	23	13
1	11	24	13
1	18	31	13
1	11	25	14
1	15	29	14
1	18	June 1	14
1	11	May 26	15
1	18	June 3	16
2	17	3	17
1	15	2	18
1	17	4	18
1	18	5	18
1	15	4	20
1	19	8	20
2	12	4	23
1	17	9	23
6	14	7	24
1	16	9	24
3	13	7	25
3	14	8	25
1	15	9	25
1	17	14	28

TABLE 11. DURATION OF INCUBATION PERIOD OF *Merodon equestris* EGGS DURING MAY AND JUNE, 1926

No. of eggs	Date of Deposition 1926	Date of Hatching 1926	Duration of incubation period Days	Remarks
2	May 30	June 9	10	
2	June 1	11	10	
3	May 15	May 26	11	
5	17	28	11	
3	18	29	11	
5	19	30	11	
1	22	June 2	11	
6	23	3	11	
2	24	4	11	At 1:00 p. m.
4	25	5	11	
1	27	7	11	
5	29	9	11	
6	15	May 27	12	Several hatched by 7:30 a. m.
12	18	30	12	
4	19	31	12	
100	18	30	12	
51	21	June 2	12	
32	22	3	12	
5	23	4	12	
3	24	5	12	
2	25	6	12	
1	30	11	12	
1	15	May 28	13	Hatched by 9:15 a. m.
51	18	31	13	
3	19	June 1	13	
31	20	2	13	
5	21	3	13	
1	22	4	13	
1	24	6	13	
2	21	4	14	

It is evident from the above measurements of larvae that the greatest increase in size takes place during the first two months.

NATURE AND EXTENT OF INJURY IN BULBS

From the evidence thus far obtained it appears that the newly hatched larvae begin feeding in the basal plate of the bulbs, and later bore through the centre of the bulb, causing it to assume a badly discolored and soft or rotted appearance.

Eggs laid May 18 were placed on a bulb and allowed to hatch there and infest it without being disturbed. This bulb was cut open on June 3, after the larvae had entered it, and five distinct holes were found bored

through the basal plate. One of the larvae was feeding near the top of the bulb. After they had been feeding for eight days the centre of the bulb was blackened.

A larva that hatched on May 28 was placed on a bulb and allowed to feed in it for a week. On examination it was found that the larva had burrowed down through one of the outer bulb scales from the neck to the basal plate, leaving a brownish and discolored channel to mark its trail, and had then turned and started to eat its way back through the centre of the bulb.

Another small bulb was completely destroyed after five weeks feeding by a larva that had hatched on May 28. This larva had then abandoned the bulb and crawled outside into the soil. On July 7 the basal plate of a large King Alfred narcissus bulb was discolored after five weeks feeding, but the centre had not yet been touched. A six weeks old larva that had been feeding in one bulb for 19 days had practically destroyed the centre of it. On July 26, another larva that had been feeding in a bulb for three weeks had damaged it considerably, and had then gone down into the basal plate.

Degree of Infestation. To illustrate the severity of infestation by the three bulb pests of the bulb material which was available for the fumigation experiments, the following observations based on the results of examination of 498 bulbs are presented:

A total of 383 *Merodon* larvae were present in 349 infested bulbs; 313 of these bulbs contained only one larva in each bulb; 32 had two; and 2 had three.

One hundred ninety-five bulbs were infested with *Eumerus* larvae and contained 1066 specimens. The maximum number counted in a single bulb was 42.

A total of more than 34,204 mites, including mature, immature, and hypopal stages, were counted in 376 infested bulbs.

Control Experiments

Carbon Disulphide Fumigation of Infested Bulbs. Late in November 1925, a supply of King Alfred narcissus bulbs that had recently been imported from Holland was forwarded to this Bureau for experimental use. As already stated, these bulbs were heavily infested by larvae of both species of bulb flies, and all stages of the bulb mite.

These infested bulbs afforded an excellent opportunity to get data on the practicability of fumigation with carbon disulphide without the use of vacuum or other special equipment for vaporizing the chemical more rapidly. The object was to place in the hands of the grower a simple and

effective method of treating bulbs under field conditions for the control of these bulb pests, especially in cases where nematode (*Tylenchus dipsaci*) infestation did not occur and make necessary resort to the hot water treatment. With this purpose in mind a series of preliminary experiments were planned. The results of these tests proved to be so decisive not only in regard to insect and mite mortality, but also in their effects on the subsequent growth and flowering of the bulbs, that it was decided they should be published in order to make the information available as a basis for future investigation of this problem. Owing to the fact that these results are based on long exposures and are only preliminary in scope they cannot be used as a basis for making actual control recommendations until more extensive work has been done. They do, howver, serve to suggest the possible range of effectiveness of this fumigant. Especially, provided the chemical can be vaporized fast enough to permit short exposures that would insure insect mortality without injuring the bulbs. The summarized results of these experiments are presented in the form of three tables.

A series of eight of these fumigation tests were conducted during the month of December 1925. Since these experiments are presented in the same order in each of the three tables, and include bulbs that were fumigated at the same time under identical conditions, a statement of the conditions of treatment will apply in each case.

Experiment No. 1 represents an untreated "check;" No. 2 was fumigated at the rate of 10 pounds of carbon disulphide per 1,000 cubic feet of space, under a 27-inch vacuum, and with an exposure lasting 2 hours; Experiments No. 3 to 8 were fumigated under normal atmospheric pressure; No. 3 was fumigated at the rate of 10 pounds, and with an exposure lasting 2 hours; Nos. 4 and 5 were fumigated at rates of 10 and 15 pounds respectively, and with exposures of 23½ hours; Nos. 6 and 7 were fumigated at the rate of 20 pounds, and with exposures lasting 12 and 23½ hours respectively; No. 8 was fumigated at the rate of 30 pounds and the exposure lasted 23½ hours.

The dosages used were based on the work with vacuum fumigation done by the California State Department of Agriculture, which placed a limit of from 25 to 30 pounds of carbon disulphide per 1,000 cubic feet, under a 27-inch mercurial vacuum and with a 1¾ to 2 hour exposure, as the dosage rate for bulb fumigation. The length of exposure was increased to 23½ hours when it was found in Experiment No. 3 that under normal atmospheric pressure at least one-fourth of the amount of carbon disulphide liquid used failed to vaporize within two hours, even at a dosage rate as low as 10 pounds per 1,000 cubic feet of space.

The dosage rates in subsequent experiments were also increased because the 10 pound rate with an exposure lasting 2 hours had proved ineffective, even under a 27-inch vacuum.

The data on insect control presented in Table 12 are the composite results of examination of from two to four different lots of infested bulbs at varying intervals of time after the fumigation. The first examination in most instances was made in December 1925, approximately ten days after treatment. Other examinations were made early in January, and the final examination was made about the middle of March in 1926.

TABLE 12. RESULTS OF FUMIGATION WITH CARBON DISULPHIDE UNDER NORMAL ATMOSPHERIC PRESSURE OF KING ALFRED NARCISSUS BULBS INFESTED WITH LARVAE OF *Merodon equestris*, LARVAE OF *Eumerus strigatus*, AND BULB MITES, *Rhizoglyphus hyacinthi*

Exp. No.	Date of fumigation 1925	Dosage CS_2 per 1000 cu. ft. Pounds	Length of exposure Hours	Total No. of bulbs examined	Effects of fumigation on *M. equestris* larvae No.	Control Per cent	*E. strigatus* larvae No.	Control Per cent	*R. hyacinthi* mites No.	Control Per cent	Remarks
1	Dec. 2	0	0	62	40	0	113	0	6044	0	Check, untreated
2	2	10	2	62	41	2.4	93	0	5096	0	27″ vacuum
3	2	10	2	62	37	0	116	0	8971	0	
4	16	10	23½	30	28	100	89	100	2220	90.0	
5	16	15	23½	30	25	100	107	100	933	96.0	
6	16	20	12	30	28	100	68	100	1856	97.8	
7	3	20	23½	110	90	100	300	100	5160	96.0	
8	3	30	23½	112	94	100	180	100	3924	99.4	

It is evident from the negative results of the first three experiments presented in Table 12 that dosages of 10 pounds of carbon disulphide and exposures lasting only two hours were ineffective in killing the bulb fly larvae and the mites either under a 27-inch vacuum or under normal atmospheric pressure. In fact there was no significant difference between the results of these tests and the untreated check. Although one dead *Merodon* larva was found in Experiment No. 2, there was some doubt whether this particular individual had died as a result of the fumigation. Experiments No. 4 to 8 inclusive gave 100 per cent mortality of the bulb flies, and a very high mortality of the bulb mite. In fact the earlier examinations of bulbs fumigated at the rate of 30 pounds and with an exposure of 23½ hours did give 100 per cent mortality of mature, immature, and hypopal stages of the mites. A few individuals, however, were present in the samples of bulbs that were examined during March, and these reduced the final percentages slightly, so that the mortality varied from 90 to 99.4 per cent.

In order to get a final check on the ultimate recovery or death of the bulb pests infesting this material, a sample of 20 bulbs from each of the 8 experiments was set aside and the flats in which they were planted were left undisturbed in the cold frame over winter. In the spring a screen frame was built over the flats to prevent the escape of any flies

that might emerge from the bulbs. Records were kept of such emergences, and the bulbs were eventually cut up and examined to determine whether they still contained any dead larvae, pupae, or mites. These results are presented in Table 13, and provide a very satisfactory check on the earlier results. No flies emerged except in the first three experiments in which living larvae and mites had previously been found. Only dead larvae, and very few mites could be found in Experiments 4 to 8 inclusive.

TABLE 13. FINAL EFFECTS ON *Merodon equestris*, *Eumerus strigatus*, AND *Rhizoglyphus hyacinthi* IN KING ALFRED NARCISSUS BULBS THAT WERE FUMIGATED WITH CARBON DISULPHIDE UNDER NORMAL ATMOSPHERIC PRESSURE IN DECEMBER 1925, AND GROWN OUTDOORS UNTIL MAY 1926

						M. equestris			*E. strigatus*			*R. hyacinthi* No. of mites		
Exp. No.	Date of fumigation	Dosage CS_2 per 1000 cu. ft.	Time of exposure	No. of bulbs examined	Date of examination	No. flies emerged	No. pupae not emerged	No. larvae dead	No. flies emerged	No. pupae not emerged	No. larvae dead	Dead	Alive	Remarks
	1925	Pounds	Hours		1926									
1	12/2	0	0	20	5/20	12	6	0	20	4	0	0	2143	Check, untreated
2	12/2	10	2	20	5/20	6	3	0	3	1	0	0	1366	27 inch vacuum
3	12/2	10	2	20	5/20	14	1	0	14	4	0	0	1759	
4	12/16	10	23½	20	5/1	0	0	12	0	0	6*	0	89	
5	12/16	15	23½	20	5/1	0	0	14	0	0	9*	0	14	
6	12/16	20	12	20	5/1	0	0	15	0	0	18*	0	35	
7	12/3	20	23½	20	5/1	0	0	12	0	0	0*	0	32	
8	12/3	30	23½	20	5/1	0	0	13	0	0	3*	0	22	

*Larvae badly decomposed; some unrecognizable.

The results presented in Table 14 show the effects of fumigation on the vegetative and flowering qualities of the bulbs and are based on the same samples of bulbs as those mentioned in Table 13. The data on flowering were taken on April 19, 1926, at which time the bulbs were already blooming. The results for the first three experiments, as indicated by the number of blooms, do not show any significant difference that cannot be explained by the fact that the hearts of some of the bulbs were no doubt destroyed by larval feeding and were thus prevented from blooming. The lack of blooms in Experiments 4 to 8 is attributed to the injurious effects resulting from the long exposure to the carbon disulphide fumigation. In Experiments No. 7 and 8, where dosages of 20 to 30 pounds were used, the treatment was absolutely fatal, and in fact the injury showed up soon after treatment as a brownish discoloration of the basal plate of the bulbs. By reducing the exposure to 12 hours, a few bulbs managed to survive a dosage of 20 pounds, and even produced a couple of blooms.

TABLE 14. FINAL EFFECTS ON THE VEGETATIVE AND FLOWERING QUALITIES OF KING ALFRED NARCISSUS BULBS THAT WERE FUMIGATED WITH CARBON DISULPHIDE UNDER NORMAL ATMOSPHERIC PRESSURE IN DECEMBER 1925, AND GROWN OUTDOORS UNTIL MAY 1926

Exp. No.	Date of fumigation 1925	Dosage CS_2 per 1000 cu. ft.	Time of exposure	No. of bulbs examined	Date of examination 1926	Effects of fumigation on bulbs: No. of rotted bulbs	No. of bulbs with Roots	No. of bulbs with Foliage	No. of bulbs with Flowers*	Remarks
1	12/2	0	0	20	5/20	1	19	19	8	Check, untreated
2	12/2	10	2	20	5/20	1	18	18	7	27 inches vacuum
3	12/2	10	2	20	5/20	1	19	16	7	
4	12/16	10	23½	20	5/1	5	7	11	2	
5	12/16	15	23½	20	5/1	19	1	1	0	
6	12/16	20	12	20	5/1	15	5	5	2	
7	12/3	20	23½	20	5/1	20	0	0	0	
8	12/3	30	23½	20	5/1	20	0	0	0	

*Records on Flowering were taken on April 19, 1926.

PRESIDENT ARTHUR GIBSON: Mr. C. A. Weigel will now read his paper.

HOT-WATER BULB STERILIZERS

By C. A. WEIGEL, *Entomologist, U. S. Bureau of Entomology, Washington, D. C.*

ABSTRACT

A brief discussion of the various types of sterilizers used to disinfect narcissus bulbs imported under special permit and in accordance with the Federal Horticultural Board requirements.

According to the present restriction, which became effective January 1, 1926, governing the entry of narcissus bulbs from foreign countries, all such imported bulbs shall be given the hot water treatment either at the port of arrival or other designated point, provided suitable equipment is available at such a place. Such treatment "involves the submersion of bulbs in wire baskets, slat boxes, or other containers, in water ranging in temperature from 110° to 111.5°. F., for a period of not less than two and one-half hours." The object of this restriction is to prevent the further entry into this country of the three important bulb pests, viz., the narcissus fly, *Merodon equestris* Fab; the lesser bulb fly, *Eumerus strigatus* Fallen; and the bulb nematode, *Tylenchus dipsaci* Kuhn; against which the hot water treatment is supposed to be effective.

Subsequent to the issuance of these requirements numerous requests were received by the Department of Agriculture for information regarding the construction and operation of such sterilizers. A preliminary survey of the subject soon revealed that comparatively little was known in this country concerning equipment for treating bulbs in hot water.

In view of this fact it seemed desirable to undertake a study of the

underlying principles involved in the construction of apparatus for this purpose, particularly the methods employed in maintaining a constant and uniform temperature of the water throughout the period of treatment. One source of such information was the literature available on the subject. Another, was the sterilizers, limited in number, which had already been constructed in this country prior to the placing of the restriction. A third source was the data which each permittee was required to furnish and file with the Board when application was made for a special permit to import narcissi, the information being needed in order to determine whether the importation could be adequately handled. These data consisted of a detailed description of the proposed apparatus illustrated with plans and photographs, and through the courtesy of Dr. C. L. Marlatt and Mr. E. R. Sasscer, of the Federal Horticultural Board, they were placed at the writer's disposal. The writer is indebted for assistance rendered by Mrs. A. E. Harrell in the office of the Board, in assembling these data from the various files pertaining to this subject.

According to the literature available it is apparent that the most important developments in foreign countries are due to the researches of Ramsbottom, of England, and Van Slogteren, of Holland.

Ramsbottom, (*1, p, 481–483*), whose investigations were begun in 1916, ultimately found that by soaking narcissus bulbs in water at a temperature of 110° F. for three hours the bulb eelworm, *Tylenchus dipsaci*, could be destroyed without injury to the growth of the plant. The period of three hours should be recorded from the moment the bulbs are placed in the bath because, in deciding upon the three hours' treatment, allowance was made for the fall of several degrees in temperature that always takes place when the bulbs are immersed. This drop in temperature, however, is generally regained in from 15 to 30 minutes.

Van Slogteren, (*2, p, 14*), simultaneously, but working independently, arrived at virtually the same conclusions.

This treatment is also claimed to kill the larvae and pupae of both species of bulb flies, *Merodon equestris*, and *Eumerus strigatus* Fallen.

In this country C. E. Scott (*3, p. 502*), of the California Department of Agriculture, has conducted some experiments for the control of the bulb nematode, and concludes that the "treatment of bulbs in hot-water at 110° Fahrenheit for three hours is the most promising method." Similarly, C. F. Doucette (*4, p. 250*) points out that "The information in the table substantiates the statements that the standard three-hour treatment at 110° Fahrenheit is fatal to the fly larvae and mites."

As a result of Ramsbottom's and Van Slogteren's work, commercial

concerns became interested and three types of apparatus were devised, two of which are somewhat similar in principle and construction. The earlier of these consisted of an outer kettle, which in some cases was insulated, and an inner tank of metal with perforated sides or wire baskets suspended for holding the bulbs in the water bath. The water within the inner tank is heated by means of a gas or oil flame applied directly to the rounded bottom. The constancy of temperature of the water is controlled by a hand-operated valve, or by a thermostat which, operating a specially devised valve, regulates the flow of gas or oil.

In England one of the thermostatically controlled types, known as the Hearson Bulb Bath, is now available in three sizes, the smaller one having a holding capacity of about 200 medium-sized bulbs, and is designed for use by the hybridist and grower of small stocks of expensive varieties. The next size will hold 84 pounds, while the largest bath can treat 150 pounds at one time. For convenience of handling and changing the bulbs, especially in the larger outfits, it is desirable to soak them in open, coarse sacks, each sack holding about 42 pounds of bulbs.

In Holland an apparatus known as the "Armadill" sterilizer, was developed by Dr. Van Slogteren (*5*), is available, and involves virtually the same principles as the ones just described. It is circular, or kettle shaped, is about 42 inches in diameter by 36 inches deep, and has a capacity of about 150 liters. It has an outer metal wall, insulated with cement, and is provided with a specially designed thermometer which can be read at a distance of several feet. To assist the thermal circulation three iron pipes, open at the ends, are strapped together in a row and placed in an upright position in the middle of the tank, the lower ends resting on a slat floor placed several inches from the bottom. These pipes also serve to keep the bags of bulbs from jamming each other and forming a solid mass, which might interfere with the circulation of the water among the bulbs.

In these first types that were developed in Holland and England no special provision appears to have been made for agitating or circulating the water, the heat being distributed chiefly by thermal circulation. This is a vital factor in the efficiency of such equipment. According to D. B. Mackie (*6, p. 26*), of the California Department of Agriculture, the time required to heat a bulb varies with its initial temperature and with the extent of agitation of the water. For example, still water at 110° F. requires about sixty minutes to bring to 110° the temperature of the centre of a 2-inch bulb whose initial temperature is 69°. The same bulb, submerged in violently agitated water, takes up heat sufficient to raise its temperature to 110 degrees in 20 minutes, thus shortening

the period by 40 minutes. The effect noted is consistent with the experimental results of heat transmission.

The second type of apparatus, known as the Barford and Perkins Sterilizer, consists of a boiler for supplying steam to heat the water in the one or more circular tanks, and a steam coil provided with a specially patented arrangement of valves for controlling the temperature. It is constructed in two standard sizes, with a soaking capacity of 5 cwt. and 8 cwt., respectively, for each circular tank.

The steam boiler, which when set up is about 10 feet away from the tank, is of the low-presssure type, being 2 feet in diameter by 4 feet 6 inches high, and is provided with a pressure gauge and safety valve and 12-foot chimney. An automatic feed maintains the water in the boiler at a constant level and is so arranged that it can be coupled to the cold-water supply. A pressure head of not less than 8 to 10 feet of water is required to supply the automatic feed tank. The boiler is set to blow off at a gauge pressure of 2 pounds. The firebox of the boiler will burn coal, coke, wood or peat, and can also be constructed for burning oil or gas. Electric energy can also be used as a source of heat.

The circular tank for the 500-pound capacity is 3 feet 6 inches in diameter by 3 feet 6 inhes high; that for the 900-pound outfit is 4 feet 6 inches in diameter and 4 feet high. The tank is fitted with a set of special valves which control the amount of steam admitted to the coil, which in turn maintains the temperature of the water The coil is located on the bottom of the tank, below the slat floor upon which the bulbs rest during treatment. The slat floor is about 10 inches above the bottom and prevents the bulbs from coming in contact with the steam coils. A draw-off permits quick emptying of the water and cleaning out. The capacity of the equipment can be increased by adding a second tank, for the heating of which the boiler is fitted with a three-way cock. There is but one size of steam boiler, which is supplied with each outfit, the difference being in the size of the tanks. The coal consumption is given as less than 80 pounds per day of 10 working hours. Three soakings can be made in a ten-hour day, giving a total of $1^1/_5$ tons with the 8-cwt. plant.

The thermometer for this plant is of special pattern. It is about 4 feet long, and is enclosed in a brass tube fitted with a disc, which allows the thermometer to rest on the central pipe, immersed to the correct depth. This central pipe is perforated, and enables the temperature to be read in the centre of the mass of bulbs; but this brass-cased thermometer can be immersed at any other part of the tank without fear of breakage. The column of mercury is flattened, so as to be as wide and as easily read as possible, and the scale is a very open one, i. e., only a few degrees are marked on either side of the working temperature. It is, therefore, possible to have a large and very obvious rise of the mercury column for each degree Fahrenheit, so that the thermometer can be eas ly read from a distance of 12 to 15 feet. A red mark is drawn across the scale at 112°, showing the point above which the temperature of the water cannot be allowed to rise without risk of injuring the bulbs.

When sterilizing, the supply of steam is regulated to maintain the water in the sterilizing tank at the correct temperature, by opening or closing one, two, or three of the valves. Valve number 3, which is nearest to the tank, has the smallest opening, while number 1 has the largest. It is claimed that the temperature can be adjusted to vary not more than one-half of a degree Fahrenheit. As in the previously mentioned

type, the circulation is entirely thermal, and in order to allow space for the water to circulate freely the bulbs are placed in coarse mesh bags filled not more than half full.

In the United States according to the records of the Federal Horticultural Board, about a dozen of these machines have been installed since the restriction has become effective, and all appear to be giving satisfaction. The largest of these, located near Los Angeles, Calif., consists of three 900-pound tanks, and a boiler, which is heated by conveniently available natural gas.

In operation, according to the reports from the various inspectors of the Federal Horticultural Board who have supervised the treating of imported bulbs in the past season, there appears to be a drop of 6 to 8 degrees in temperature when the bulbs are immersed, and from 15 to 20 minutes are usually required to regain this loss before the whole mass becomes equalized in temperature. This was accomplished by opening all four valves until the temperature rises to 111° F., after which number 1, and if necessary number 2, were closed, to maintain a constant temperature.

The third type, also a Barford and Perkins sterilizer, is essentially the same in principle and in construction, with the exception that provision is made to circulate the water in two distinct circuits. This type was really the forerunner of the one just described. Because of its large size, however, its usefulness was limited to concerns growing very large quantities of bulbs. To meet the demand for a smaller outfit, which could be used by growers of less acreage, the second type was evolved.

Since the first equipment was made in Holland, it has been improved so that the heating can be done by means of either hot water coils or gas burners. The apparatus is known as the "Bloembollen Ketel met Telegas regulateur" and is manufactured by the Gebr. Schouten, Lisse, Holland. One of the newer designs, which was installed and tested at North, Va., early in August, 1926, performed very satisfactorily during the 3 hours of testing. This apparatus consists of a hot-water boiler and two sheet-iron tanks, each 7′ 6″ long, by 4′ 6″ wide and 2′ 6″deep. These dimensions, however, may be varied according to the capacity desired. There is a slat floor, raised approximately 10 inches from the bottom, allowing a depth of 20 inches for actual treating space. Lying on the bottom are the hot-water coils which heat the water. Each tank is divided into five sections by four upright 3-inch pipes, fastened together in a row, but open at each end. The pipes, open at both ends, serve two purposes; they facilitate thermal circulation and keep the bags of bulbs separated, thereby preventing them from forming too solid a mass during the treatment. In each of the sections it is possible to

place four bags of 1½ bushels each, allowing a total of 20 bags, or 30 bushels of bulbs. With both tanks in operation it is possible to treat 60 bushels in one charge.

The temperature is controlled by a specially designed, water-actuated thermostat. The apparatus is provided with a large thermometer in each tank, somewhat like that used in the English sterilizers. In determining the temperature of the bulbs during the treating period, it was found that there was a difference of ¼ to ½ degree in temperature between the water in the tank and that in the inside of the gunnysacks filled with bulbs.

This apparatus can also be equipped for direct heating by gas rings placed underneath the tanks, the thermostat in such cases controlling the flow of gas, thus holding the temperature within the desired range.

According to Mr. M. Kisliuk, who supervised the treating of imported bulbs in one of the "gas-heated" machines near Reading, Pa., the thermostatic control functioned satisfactorily. A fairly constant and uniform temperature of 110.5° F. was maintained throughout the bulb mass during the period of treatment. For the safety of the bulbs, the thermostat is set so that the temperature cannot exceed 112° F. Similarly, Mr. F. W. Hecker, an inspector of the Federal Horticultural Board, who supervised the treatment of imported bulbs in this type of gas-heated apparatus at Benton Harbor, Mich., reports that "After removing one batch of bulbs and inserting another, it would cause the temperature to drop 5 to 7° F., but it very seldom took more than 15 to 25 minutes to bring the temperature up to 110.5° F. again."

California Bulb Sterilizer

In the United States the pioneer investigation of this subject was made by D. B. Mackie and his associates, of the California Department of Agriculture. As early as 1921 a dipping vat was developed and used in connection with treatment of certain kinds of nursery stock. This apparatus differs from others in that it is electrically heated and thermostatically controlled. With the rapid expansion of the bulb industry in California the demand for effective treatment of infested bulbs became urgent and resulted in the improvement of the dipping vat, so that a very efficient type is now available.

This latest equipment now known as the California Floral Bulb Sterilizer, consists of a tank made of heavy sheet metal 9′ long, 2′ wide, and 2′ deep to a horizontal wire screen. The frame is reinforced with angle iron, and the tank is insulated with asbestos. The asbestos insulation is protected on the outside by tongue-and-groove sheathing.

The bottom below the screen is either rounded or V-shaped, with a depth of 15 inches below the false bottom or screen, on which rests the baskets.

Each vat is provided with seven baskets, five being in the vat at one time; two auxiliary baskets can be filled or unloaded while the others are in the process of treatment. The contents by volume of each basket is 5½ cubic feet, but, to enable freer movement of the bulbs, a load is limited to 4 cubic feet. The baskets are placed in the vat and removed from it by means of a tackle and merchandise conveyor; they are placed in the vat in rotation at 30-minute intervals, the first basket being removed at the end of 2½ hours and replaced by a fresh one. The next is removed 30 minutes later, and so on. This rotation provides for the least possible disturbance of the water temperature and for a better distribution of labor.

Heating is accomplished by two 220-volt immersion heaters of the bayonet type, each having a rated capacity of 4 kilowatts. A thermostat operates a relay, which in turn actuates the switch controlling the immersion heaters. To insure a uniform temperature and to assist in the rapid transfer of heat from the water to the bulbs, the water is kept in agitation throughout the treatment. In the first sterilizers developed this was accomplished by means of an 8½-inch propeller set in the end of a 12-inch sheet-metal pipe, which lies longitudinally in the bottom of the tank. In the recently improved types it appears to be done by means of a centrifugal pump, which discharges water directly among the bulbs through a series of jets under the screen bottom, one jet being placed under each basket. In either case, power for agitation is derived by means of a motor connected either directly or by a belt to a propeller or a pump.

This type of sterilizer requires that provision be made for having preheated water on hand; when it is to be used, the vat is first filled with hot water of approximately the desired temperature, and then operated with the electric immersion heater, thermostatically controlled. In sections of the country where cheaper electric current is available as on the Pacific Coast, for example, this type of vat can be heated by electricity alone, unless, of course, the time required for heating the water to the desired temperature of 110° F. is an important factor.

Steam-Heated Sterilizers

Since bulbs are now being grown extensively in certain districts of the Pacific Northwest, the growers soon realized the need of treating their bulbs in order to be able to maintain clean stock. Profiting by the ex-

perience of others, they developed a new and unique style of bulb sterilizer. In it steam is used for heating the water in a separate heater, and the temperature is kept constant and uniformly distributed by means of both agitation and circulation. The makers and first users of this apparatus appear to be W. C. Franklin, of Portland, Oregon, and F. A. Chervenka, of Sumner, Washington, both being extensive growers.

Mr. Franklin describes this sterilizer in the Florists' Review, Volume LVII, No. 1475, issued March 4, 1926, pages 34 to 36, as follows:

An iron tank was employed, but wood will do as well, about nine feet long, three and one-half feet wide, and three and one-half feet deep At one end of the tank an 8-inch marine propeller was placed close to the bottom, operated by an electric motor and set to run at 875 revolutions per minute, for the purpose of circulating the water. About twelve inches from the bottom, a false floor made of boards running horizontally with the tank was inserted. There is a space of six inches on both sides of this false bottom to allow the water to come up along the sides of the tank.

On the other end of the tank there is an outlet pipe, connected with a rotary pump. From this outlet pipe the water is pumped through a water heater, which consists of a water jacket inside of which is a copper coil. Enough steam is sent through this copper coil to keep the water at the required temperature The steam is controlled with two ⅜-inch and two ¼-inch needle valves. One valve of each size will control the flow of steam just as well as two.

In heating the water at first, a live steam pipe is carried from the boiler into the tank, and the steam is used to raise the water to the desired temperature, 111° Fahrenheit, after which the heater is used to keep the water at that temperature. When the water is taken through the outlet and pumped through the heater, it is carried back to the tank and released behind the propeller, and it is again sent circulating among the bulbs. The water is maintained at a uniform temperature at all times.

No difficulty has been found in holding that even temperature. In the treatment of our bulbs the temperature of the water has never gone below 110 degrees nor above 111½ degrees. To keep watch on this, a certified thermometer has been used, and the circulation has been so good that we have not found any variation of temperature in any part of the tank.

As containers for the bulbs, we used baskets made from ½-inch mesh wire screen, made on frames twenty-four inches deep, thirty inches long and twelve inches wide, outside measurements. These were constructed so that the top part of the frame extends over the edge of the tank far enough to allow the baskets to hang on the edge. There is space between the baskets, and between the baskets and the walls of the tank, to insure a good circulation of the water. The capacity of the tank is about one-half ton of bulbs.

The writer has had opportunity to test several machines of this type, and has found that they performed very satisfactorily when operated on high-pressure steam. If the steam pressure dropped too low, however, difficulty was experienced in maintaining a constant and uni-

formly distributed temperature. Aside from the cost, this apparatus may be considered very desirable and efficient, because the water can be heated quickly to the desired temperature, and the temperature can then be maintained satisfactorily. In addition, it has two distinct systems for keeping the water in motion, i. e., by circulation and by agitation. Its disadvantages are that the temperature-control valves are operated by hand and the temperatures must necessarily be checked by accurate thermometers at frequent intervals.

This type of sterilizer has been further improved by assembling and attaching the pump, motor, water heater, and control valves to one end of the tank, thereby obviating installation of these parts on the floor and walls of the building in which it is set up. This equipment is known as the "Rogers" type, a patent for which is now pending.

United States Department of Agriculture Bulb Sterilizer

During the spring of 1926, R. L. Swenson, Mechanical Superintendent of the Department of Agriculture, and the writer devised plans for the construction of a sterilizer incorporating most of the ideas which have thus far been brought out. In this apparatus the heating is done by steam coils which are placed in the bottom of the tank, and the temperature is controlled by means of an air-actuated regulator, or thermostat. This thermostat is of the automatic bimetallic immersion type, and admits or discharges air by the expansion and contraction of the metallic element, actuated by the minute changes in the temperature of the water in the sterilizer. The air is admitted to or released from a diaphragm valve, which in turn admits or throttles the steam supply. The water is agitated by two marine propellers, one placed in each end of the tank and driven by an electric motor, their action making two circuits of water in the vat. The tank is of virtually the same dimensions as those devised by Mr. Mackie and growers in the Northwest. The details of construction can be varied according to the availability of the materials, wood or metal, in a given locality. It is equipped with two electric immersion heaters, so that if one source of heat gets out of order the other can be used. The water is brought to the critical temperature by injecting live steam through special hot-water heaters, after which the heat is maintained by either the automatically controlled steam coils or the electric immersion heaters. A recording thermometer can be used to keep for reference the temperatures during each charge. To facilitate handling the bulbs, transferring them into the vat and out of it, a chain hoist and overhead traveling carriage is provided.

Since this apparatus incorporates many of the desirable features of the various machines thus far developed, its construction necessarily costs more, but its efficiency is accordingly increased.

The types thus far described are of sufficient capacity to suit the needs of the average grower; and by adding one or more units the requirements of a larger establishment can be met. But there are several commercial concerns of such size that they require equipment of a much greater capacity than those discussed above.

One of these mammoth plants has been installed near Charleston, South Carolina, and has a treating capacity of almost 100,000 bulbs in one 3-hour charge. The unique feature of this plant is that the heated water is passed down through the bulb mass.

The equipment consists of a huge boiler, designed for wood burning, and a sterilizing tank about 36 feet in length. The tank is divided into 5 compartments, each capable of holding 5 specially designed wire baskets. A continuously traveling crane is installed over the sterilizing vat, the loading, the cooling, and the unloading platforms. To this traveling crane is attached a loading frame designed to hold five sterilizing baskets, which constitute the contents of one compartment.

There are two vapor-operated recording thermometers, graduated in degrees Fahrenheit, and each is equipped with a device to safeguard the instrument from excessive temperatures. One temperature recorder is attached to the inlet, and the other to the outlet, of the water-circulating system of the sterilizer. The inlet recorder has a high-temperature alarm, which rings if the temperature exceeds 111° F.

The equipment also includes an arrangement for sterilizing the fouled, or used, water after every third or fourth batch of bulbs. This is accomplished through "by-passing" the steam directly into the heater, eliminating the temperature control from the circuit. The fouled water is then brought to 150° F., and can be held there for any desired period. Such treatment is considered sufficient to kill all stages of the bulb nematode. When the whole system is emptied the steam piping is so arranged that it is also possible to sterilize with live steam all parts of the sterilizer, including the dripping pit at the end of the vat, located underneath the dripping platform.

As the steam is generated it is fed to an instantaneous water heater capable of raising the temperature of 3,500 gallons of water from 70° F. to 110° F. in one hour, at a steam pressure of 15 pounds. Steam is fed to the heater by a supply pipe through a Sylphon regulator, set at 110° F. This supply pipe is used to add the initial heat to the water before the immersion of bulbs. After the water is heated to about

110° F. the bulbs are immersed and brought to the critical temperature, then this supply pipe is closed and a much smaller one is opened, to furnish the steam for replacing the heat lost from the entire system by radiation. This smaller steam supply pipe is equipped with a Sylphon steam regulator having a range of 100° to 140° F. but set for 110° F. when in operation.

The path of the water through the system is as follows: The water is discharged from a centrifugal pump driven by a gas engine, having a capacity of 200 gallons per minute, against a 40-foot head. The water then passes through the heater, its velocity being slowed down as it flows over the steam coil, and continues on to the sterilizing vat, where it is discharged into a distributing header. From this header five nozzles discharge into the upper part of each of the 5 compartments of the vat. Each unit of 5 nozzles is provided with a valve, to throttle the flow according to the requirements. The water now passes down through the bulbs by gravity and is drawn into a common header at the bottom of the tank, each of the compartments having two openings. From the common discharge the water is drained into a settling tank, provided with a baffle, intended to direct the flow of water so that all heavy materials will be collected at the bottom. The suction side of the centrifugal pump is connected to the top of the settling tank, thus completing the circuit of the water.

A second huge plant is located on Long Island, N. Y., and has a treating capacity of 60,000 bulbs per charge. In addition to the boiler and two large water heaters, this equipment includes a battery of six metal tanks, each with a treating capacity of about 80 cubic feet. To prevent loss of heat by radiation the metal tanks are insulated with a wall of hollow tile. Four specially made wire baskets, each of approximately 12.5 cubic feet capacity, and provided with covers, are made to fit each tank, so that when completely loaded the apparatus holds a total of 24 baskets. The temperature of the water is controlled by a thermostat actuating a solenoid-operated valve, which apparently performs very successfully.

The movement of water in this outfit is accomplished by means of a unique system of circulation. The preheated water is injected into the bottom of each tank so that it enters the baskets of bulbs from underneath and rises up through the mass of bulbs. An overflow outlet near the top allows the water to return by gravity into a huge collecting sump or vat, where it is screened and filtered and then pumped back through the steam coil heaters, where it is again brought up to the critical temperature, and sent through the mass of bulbs as before.

The water is preheated in the following manner: When starting the treatment, the sump is filled with water, the pump started, and the water circulated through the two heaters and back to the sump. In this operation the temperature-control features are eliminated through "by-passing" the water as soon as it leaves the heaters. When the water in the entire system reaches about 111° F. one of the heaters is cut off and the solenoid valve is put into service on the line from the boiler to the other heater. The solenoid valve is connected to a special thermostat which can be set at the critical temperature. If the water passing the thermostat ever exceeds 111.5° F. a bell alarm is sounded, so that the operator can by-pass the overheated water directly to the sump, thereby safeguarding the bulbs from injury caused by excessive temperatures.

The bulbs are then immersed, the "by-pass" from the heater to the sump closed, and the water allowed to circulate for the required period through the sterilization tanks containing the bulbs. By staggering the time of loading each tank, this apparatus permits a continuous operation without unduly upsetting the temperatures, as might result if it were loaded to capacity at one time.

A third large treating plant which has been installed near Sanford, Florida, includes six large tanks about 10′ x 3′ x 2′ 6″ in size, and twenty-four specially built baskets for immersing the bulbs. Its total treating capacity for one charge is about 50,000 bulbs. In many respects this apparatus is very similar to the one just described; but the water is heated in a separate tank by electric heaters thermostatically operated. After the bulbs are removed from the water bath they are cooled by placing the baskets or containers on a conveyor which carries them underneath an apparatus for spraying cold water.

Another mammoth plant has been installed near Scottsville, Texas, and has a treating capacity of approximately 100 bushels per charge. It consists of three separate metal vats, each being about 15′ long by 2′ wide and 2′ deep. Each vat is provided with 8 wire baskets, each of 5 cubic feet capacity. These baskets are lowered into or raised out of the vats with an overhead traveling crane. Agitation of the water is produced by a marine propeller, of suitable size, placed in the bottom of each vat. A steam injector is used in each vat for heating the water before the bulbs are immersed. This sterilizer is almost identical in general style and principles with the one developed by the Department of Agriculture, except that it is built in three separate units. This feature has decided advantages, especially for continuous loading and unloading, as it not only hastens the treating process but also prevents an

excessive fall in temperature which might easily result if the sterilizer were loaded to full capacity at one time.

From the reports received from the Federal Horticultural Board Inspectors who have supervised the treating of bulbs in these mammoth sterilizers, it is evident that each plant functioned satisfactorily.

In conclusion, it may be stated that while most of the types of sterilizers discussed in this article functioned more or less satisfactorily, it appears that the most efficient types are those which have the following features incorporated in their construction:

1. Provision for keeping the water in motion, either by propulsion or circulation.
2. The temperature-control device, whether manual or automatic, should be capable of maintaining the temperature accurately within closely prescribed limits.
3. The source of heat energy, whether electricity, or steam or hot water boilers, heated by gas, oil, coal, or wood, must be of sufficient capacity to bring the entire volume of water up to the critical temperature as rapidly as possible. If of sufficient capacity to do this, it will, obviously, also be capable of maintaining a constant temperature.
4. Efficient insulation is needed, to prevent too rapid a loss of heat by radiation.
5. The treating capacity should be adequate to handle within a reasonably short period of time the stock of bulbs to be treated.

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MR. E. P. FELT: May I inquire whether it is necessary to provide for the drying of these bulbs at all, or is just draining sufficient.

MR. C. A. WEIGEL: If the bulbs are to be shipped directly after treating, they must be dried. The drying process has not been gone into very thoroughly yet and is going to be a problem in case of interstate

movement, where bulbs are found to be infested and will have to be treated for interstate movement, unless they can be dried slowly in the fields or under special drying sheds.

MR. E. N. CORY: I would like to ask Dr. Wiegel whether he anticipates that carbon disulphide fumigation will be an acceptable substitute for steam.

MR. C. A. WEIGEL: Carbon disulphide is not effective against a nematode. It is necessary there to use the hot water treatment. But considerable work must be done with the use of the carbon disulphide also. There have been setbacks in some of the work, and that must be gone into a little more closely.

MR. E. P. FELT: Can you rely on its killing the larvae?

MR. C. A. WEIGEL: If it is properly done.

MR. R. B. ARNOLD: I would like to ask the price of the smaller electric heater sterilizers.

MR. C. A. WEIGEL: I think the price is about $550 f.o.b. Los Angeles, but these English machines are very small units and can be bought all the way from $31 up to $150. Of course then you have the import duty on them.

MR. W. E. FLEMING: I would like to ask Dr. Weigel how long it takes those bulbs to heat through the center.

MR. C. A. WEIGEL: According to D. B. Mackie, the time required to heat a bulb varies with its initial temperature and with the extent of agitation of the water. For example, still water at 110 deg. F. requires about 60 minutes to bring to 110 deg. the temperature of the center of a two-inch bulb whose initial temperature is 69.

MR. R. B. ARNOLD: Are the bulb flies disseminated around generally throughout all the states? Is that the reason why sterilizers have been put in?

MR. C. A. WEIGEL: No. As a result of a careful survey and checkup, we found that the bulb fly is definitely established on the west coast in certain localities only. In the East we have only one or two records of its definite and continuous establishment. After it has been established in a given locality, the tracing of that information has shown that in many cases a fly has merely emerged from bulbs that have been grown the previous fall, grown in the greenhouse and then thrown out on the refuse pile. I think in the East we have only a few records of definite establishment.

PRESIDENT ARTHUR GIBSON: The next paper is by F. F. Smith.

THE BLACK VINE WEEVIL (*BRACHYRHINUS SULCATUS* FABR.) AS A PEST IN GREENHOUSES AND NURSERIES

By Floyd F. Smith,[1] *Pennsylvania Bureau of Plant Industry, Harrisburg, Pa.*

Abstract

This paper is presented as a progress report on the studies of *Brachyrhinus sulcatus* Fabr. in the nurseries and greenhouses of Pennsylvania. Its distribution in Pennsylvania, the possibility of its being distributed by means of Taxus as balled nursery stock, and the relationship between greenhouse infestations and Taxus are discussed. Life history studies thus far indicate that greenhouse plants are infested by adults developing out of doors. The species is capable of parthenogenetic reproduction. Dry lead arsenate mixed with the potting soil gives promise of one method of control for this insect on greenhouse plants.

The black vine weevil (*Brachyrhinus sulcatus* Fabr.), also called black weevil and cyclamen weevil, has been frequently mentioned in American literature since 1890 as being injurious to various plants, especially in the greenhouses of the northern United States and of Canada. Cyclamens, primroses, and gloxinias in greenhouses, and strawberries and Taxus out of doors seem to be most frequently mentioned. In Europe, where the species is widespread, grapes are most severely attacked although peaches, raspberries, and greenhouse plants are also troubled. A list of about thirty host species has been recorded from both continents. Feytaud[2] who has made practically the only economic study of this species, found that it has one generation annually in the vineyards of France. American literature includes notes on injury and suggestions for control.

Distribution. Some disagreement is noted among our American writers as to whether this is an imported or a native insect. In Pennsylvania during the past year this weevil has been found on Taxus on a large number of Philadelphia estates. In many of the nurseries throughout the eastern part of the state adults were taken on the same plant, and none were taken by intensive collecting on other vegetation in the immediate vicinities. All these infested Taxus were either imported or were purchased from a few large New Jersey or Pennsylvania nurseries which propagate this plant in large quantities. The latter group of nurseries was found to be infested to varying degrees. In New Jersey, losses of Taxus caused by this insect[3] have been severe in some years, while the Pennsylvania nurserymen, with one exception, have

[1]The writer appreciates the advice concerning methods of study and the criticism of this paper by Dr. T. L. Guyton and Dr. C. A. Weigel.

[2]Feytaud, J. Bull. Soc. Etude Vulg. Zool. Agric. Bordeaux., Vol. 16, No. 5, pp. 33-42. May, 1917.

[3]Weiss, H. Jour. Ec. Ent., Vol. 8, pp. 552. 1915.

experienced no trouble. In the fall of 1913 one local firm imported large quantities of Taxus with roots in soil from Holland. The following spring quite a number of these plants drooped and died, and larvae thought to be those of *B. sulcatus* were found girdling the roots.

In a few nurseries where Taxus has been grown only from seed and no plants in soil have been brought in, no weevils were found. These observations point toward the probability that local distribution, at least, of this insect has been largely by means of infested nursery stock.

In eastern Pennsylvania a few commercial florists and quite a number of gardeners on estates have experienced annual losses to greenhouse plants for as long as fifteen years. In nearly all cases Taxus, infested with this weevil, has been found growing quite near each of these greenhouses.

INJURY. The young grub feeds first on the small rootlets and then, later, either devours the larger roots entirely or cuts them off and burrows into the crown or corm of the greenhouse plants. On Taxus the fleshy bark of the larger roots is eaten. The latter type of feeding is rapid and takes place as the larva is completing its growth which is in November and December in greenhouses, or in April and May out of doors.

The effect on the plant of this rapid feeding manifests itself rather suddenly; the florist usually suspecting nothing until his plants suddenly wilt down as they are being brought into bloom for the holiday sales.

The adults feed on the foliage and flowers.

LIFE HISTORY. Larvae taken May 7, 1926, from about the roots of Taxus were just completing their feeding and were forming prepupal cells. Adults emerged from this material June 16–29. Oviposition began among a few of these individuals on July 20, but the others, together with about 150 collected adults, began egg laying about August 1st. The greater number of eggs were laid during August, but a few continued oviposition until September 18th.

The eggs as laid were transferred to primroses and cyclamens in the greenhouse, where larval development was completed in about 3½ to 4 months. The maturity of these larvae during November and early December corresponds with observations on the injury to the plants and on the conditions of the insect in a number of greenhouses during the past two seasons.

At the beginning of oviposition six isolated adults were placed under greenhouse conditions where an average of 342 and a maximum of 654 eggs were laid. Ten isolated adults kept out of doors laid an average of 138 and a maximum of 377 eggs.

In order to obtain evidence on the possibility of the species breeding continuously in greenhouses, studies were begun with larvae maturing on cyclamen in November and December, 1925. From this material adults emerged during the following January and February. (The period from egg to adult under greenhouse conditions would then be 5½ to 6 months.) These adults began oviposition in April on an average of 67 days after emergence, and continued to lay eggs until October, when the greenhouse temperature dropped because of a faulty heating system. The adults then became rather inactive and fed very little. The greatest number of eggs laid during this period by one adult was 1085. Maturity of larvae from the first laid eggs took place in late July and the others developed regularly at later periods. None of the florists troubled with this insect in this locality have observed larvae or injured plants at any time other than late fall.

Further studies of greenhouse practices show that conditions are generally unfavorable for continuous breeding of this pest within doors. The houses are pretty well cleaned out by spring sales or by destruction of unsalable plants. Plants for the next season's crop are then potted up from seed flats or very small pots. If these winter-emerging adults should oviposit during the spring among the small plants, the limited root systems would furnish insufficient material for complete larval development. This is evidenced by the fact that a few newly hatched larvae will destroy the roots of a primrose in a 2½-inch pot before reaching the third instar.

PARTHENOGENESIS. Larvae isolated during 1925 developed into adults which were kept in individual cages. Eggs from each of nine isolated virgins hatched into larvae and these developed into female adults, showing that at least one generation can develop without the intervention of the male. No males have been found among the hundreds of adults examined during the course of this study. This is in agreement with Feytaud's[4] work in which he found not a single male in a dissection of over 3,000 adults.

EGG. Eggs are found tucked into soil crevices, in loose trash or leaves on the ground, or among the leaves or stems of the plants.

The egg is almost spherical, about .65 mm. in diameter, and when first laid is a glistening, pearly white color. After 24 to 48 hours the color of the majority of the eggs changes to a light brown and in 15 to 21 days they hatch into larvae. About 8 per cent to 11 per cent of the eggs, however, do not change color but finally decompose without hatching.

[4]J. Feytaud. Acad. Sciences, Paris. Vol. 165., No. 22, pp. 767–9. 1917.

This peculiarity is here mentioned since one would expect 100 per cent fertility of eggs in parthenogenetic reproduction.

LARVA. As soon as hatched, the larvae enter the ground in search of rootlets. If the surface is firmly packed the larvae seem unable to burrow into it and will die within a short time. Even firmly packed sand offers a great deal of resistance, and a smooth clay seems impenetrable. This point is suggested as the reason for the severe injury to Taxus in the New Jersey nurseries where the soil is light and porous, and the absence of the pest in injurious numbers on the same plant growing in the heavy Pennsylvania soil. The mortality of the young larvae is probably much greater in the latter situation.

After entering the soil, growth and feeding for a few weeks, or until about the end of the third instar, are slow and the larvae are usually located among the small rootlets. Feeding and growth then become rapid and the larger roots are attacked. A cell is constructed for each molt, and when mature a rather firm pupal cell is constructed. In most cases pupation takes place within two inches of the soil surface in the nurseries, although often deeper in potted plants. Since the insect is easily injured in the late prepupal or pupal condition, cultivation during late May in outdoor plantings may break up these cells.

PUPA AND ADULT. The pupal stage lasts about ten days, and after transformation the adult remains within the cell for a week or more or until the body is well hardened. The adults, whose elytrae are fused along the median line, cannot fly. They feed only at night, and are inactive during the day, hiding under trash or among the plant stems. On Taxus the greater number have been found in collections of needles among the branches, or beneath the loose bark. A dry place seems to be selected for a hiding place.

CONTROL. Control studies are now in progress. Of the soil treatments for larvae in greenhouse plants, the use of dry arsenate of lead mixed with the potting soil seems to offer some promise, as indicated by Table 1. The arsenate of lead may be readily added to the potting soil as the florist usually mixes known quantities of soil, leaf mold, manure, and sand, for each particular kind of plant.

In cage tests adults readily ate and were killed by a bait composed of dried apple waste which had been thoroughly coated with five per cent, by weight, of either magnesium arsenate or of dry lead arsenate. This same bait, together with a number of others, was applied to the soil surface about the bases of large Taxus plants but without success. The adults, whose habits in this situation were arboreal, were not lured to the ground.

Summary

1. The black vine weevil is apparently quite widely distributed in eastern Pennsylvania and seems to be associated with Taxus under out of door conditions. The distribution of this plant as balled nursery stock may be its disseminating agent.

2. Infested Taxus has been found growing in the vicinity of nearly all greenhouses in Pennsylvania where the hothouse plants have been injured by this weevil.

3. Life history studies indicate that the weevil does not ordinarily breed continuously in the greenhouses but that probably a few adults developing out of doors enter the greenhouse each season and deposit eggs.

4. According to the present knowledge, reproduction seems to be entirely by parthenogenesis.

5. Results of tests which have been made by mixing lead arsenate in the soil as a larvicide are given.

Table 1. Results of Tests Using Lead Arsenate in Potting Soil as a Larvicide for *B. sulcatus*

	No. plants	Species of host plant	Lead arsenate per bushel of soil Ounces	Date introduced 1926	Number of larvae	Instar No	Date Examined 1926	No larvae found	Remarks
A	1	Primula obconica	0.5	July 5	2	2 3	Aug. 24	0	
	1	Primula obconica	2 0	5	2	2 3	24	0	
	1	Primula obconica	4.0	5	2	2 3	24	0	
	1	Primula obconica	0.0	5	2	2 3	24	2	Check. Roots eaten.
B	1	Primula malacoides	16 0	Aug 13	4	3 4	Sept. 23	0	
	1	Primula malacoides	16.0	13	2	3–4	23	0	
	1	Primula malacoides	0.0	13	3	3-4	23	2	Check.
	1	Primula malacoides	0 0	13	1	3–4	23	0	Check
C	1	Primula malacoides	16.0	Sept 4	6	3	Oct. 19	0	
	1	Primula malacoides	16 0	4	6	3	19	0	
	1	Primula malacoides	0.0	4	6	3	19	6	Check. Roots eaten.
	1	Primula malacoides	0 0	4	6	3	19	4	Check Roots eaten.
D	2	Primula malacoides	16.0	Sept 19	120	*	Nov. 3	0	*Eggs. (60 per plant).
	1	Primula malacoides	0.0	19	60	*	3	16	Check. Roots eaten.
	1	Primula malacoides	0.0	19	60	*	3	19	Check. Roots eaten
E	2	Cyclamen	0.5	Nov. 14	6	2–3	Dec. 6	0	
	2	Cyclamen	2 0	14	9	2-3	6	0	
	3	Cyclamen	4.0	14	13	2 3	6	0	
	1	Cyclamen	8.0	14	3	2 3	6	0	
	1	Cyclamen	0.0	14	3	2 3	6	3	Check. Roots eaten.
	1	Cyclamen	0.0	14	3	2-3	6	3	Check Roots eaten.
	1	Cyclamen	0.0	14	2	2 3	6	2	Check. Roots eaten

No detrimental effect of lead arsenate at any rate of above mixtures in the soil has been noted on the plants. When introduced in the 3–4th instar very few larvae were killed in tests at any rate of mixture of lead arsenate in the soil up to 8 ounces per bushel Earthworms seemed to flourish as well in the soil containing 16 ounces of lead arsenate per bushel as in the checks.

President Arthur Gibson: We will now listen to a paper by M. A. Stewart.

A MEANS OF CONTROL OF THE EUROPEAN HEN FLEA (*CERATOPHYLLUS GALLINAE* SCHRANK)[1]

By M. A. Stewart, *University of Rochester, Rochester, New York*

Abstract

This paper very briefly describes the control of the European hen flea (*Ceratophyllus gallinae* Schrank), a potential pest of considerable economic importance to poultrymen, by spraying the buildings with Phinotas Disinfectant and dipping the birds in the same material.

The following briefly described method of control of the European hen flea (*Ceratophyllus gallinae* Schrank) was discovered during the summer of 1923, while conducting research work for the Crop Protection Institute under an appropriation from the Phinotas Chemical Company of New York City, on the control of the external parasites of domestic animals, by means of Phinotas Disinfectant. An infestation of fleas in a commercial poultry plant in Eliot, Maine was brought to the attention of the writer by Prof. P. R. Lowry of the University of New Hampshire and investigation showed these pests to be *Ceratophyllus gallinae;* eggs, larvae, pupae, and adults being found in great numbers. The means of introduction of this parasite into the plant, which is the first record of its occurrence in the state of Maine, is unknown but the effect was so serious that the owner believed that he would be forced completely out of business within a short time, due to the appalling decrease in egg production and the great loss of weight in the birds, causing them to become unmarketable. European workers have recognized the existence of this species in the United States only within the last few months, after specimens were sent abroad by the writer to prove their presence here.

This flea breeds in the nests and on the floors of poultry houses (and also perhaps in the nests of some of the wild gallinaceous birds), remaining on the host only to feed and possibly during copulation. Its life history and habits have not been at all completely worked out but it is a very active insect, breeds very rapidly, and is very hardy, being able to withstand extremely unfavorable environmental conditions. The writer has observed adults still alive after direct exposure to the weather in open trap nests filled with litter, for a period of two months. The litter in these nests had been completely soaked frequently during this time. Both larvae and adults were found here. *C. gallinae* not only attacks poultry but also any other animal, including man, which enters the infested building or comes in contact with the infested litter. However, they will not continue to live on the accidental host.

[1]This paper is presented with the permission of the Board of Governors of the Crop Protection Institute.

The insecticide used in this work was Phinotas Disinfectant manufactured by the Phinotas Chemical Company of New York City. The birds were housed in the commonly used modern type of colony house, consisting of several pens, separated by solid partitions and connected by doors cut through, under one roof. The method of control found to be effective, after determining the minimum lethal dose and the strength least irritating to the skin of the birds, was as follows: the pens were thoroughly cleaned, all of the litter being burned. The path of transportation and the ground around the burning place for a radius of fifteen feet was thoroughly sprayed with one part disinfectant to ten parts water, mixed at tap water temperature, to kill any fleas which may have escaped from the litter during transportation and burning. The droppings were buried and the ground around the burying pit was likewise sprayed for the same reason. After this was completed the first pen in the colony house was emptied of birds by placing them with those in the second pen and the walls, ceiling, roosts, dropping boards, and floor were very thoroughly sprayed with a mixture of 1 part disinfectant and 10 parts water, at tap water temperature as before, under 250 pounds pressure by a gasoline motor spraying machine, such as is used in spraying orchards. Then all of the birds in pen number 2 were dipped in a mixture of 1 part disinfectant to 60 parts water, heated to about 82 degrees Fahrenheit to lessen the physical shock. The birds were dipped at the door connecting pens 1 and 2 and were put into the previously disinfected pen, no time being allowed for the drying of either the birds or the pen. All of the pens in each colony house were treated in the same manner, progressing from one end of the building to the other by first disinfecting the pen and then dipping the birds and putting them into it.

The birds were dipped by grasping each one firmly under the wings with the right hand, immersing it in the dip, and thoroughly ruffling the feathers with the left hand, thus allowing the disinfectant to reach all of the feathers and all parts of the body. The head was immersed as well as the rest of the body, with no ill effects to the eyes. Twenty-five hundred birds were dipped in this manner and not one of them appeared to suffer any permanent ill effects. Some of the birds were groggy for a few minutes following the treatment but were soon moving about again as usual. Dipping must be done in the morning and on a warm fair day in order to eliminate all unnecessary risk of the hens catching cold or suffering other ill effects from the drenching and exposure.

There was a considerable decrease in egg production for about a week following the treatment. The exact decrease could not be determined

because the owner had failed to keep accurate egg production records after the infestation became sufficiently serious to jeopardize his business. At the end of about a week's time the egg production began to increase very rapidly and in ten days more was back to normal. This return to normal might have taken place sooner had the vitality of the birds not been so greatly lowered by the prolonged attacks of the insects before treatment. An inspection of the birds two weeks after treatment showed them to be free of lice and mites as well as fleas, which was not true at the time of treatment.

One colony house was reserved untreated as a check. For the following month the infestation in this house constantly increased, thirty-eight birds out of six hundred and twenty-five dying, due apparently to the attacks of the fleas. At the end of this time the check house and its occupants were treated. Frequent reports were received from the owner of the plant for a period of three years, during which time there was not a single occurrence of the European hen flea.

From 58 to 60 quarts of solution (1 part disinfectant to 60 parts water) were used for every 125 birds; 15 gallons of undiluted disinfectant mixed with 150 gallons of water were used to spray every five pens, each pen being 20 ft. x 20 ft. x 12 ft. at the ridge pole.

This paper is presented to entomologists not only to report a new control for an economic insect but also because during the past year and a half while doing extensive work on the taxonomy and distribution of fleas, the writer has every now and then come across specimens of *C. gallinae* from different parts of the country, specimens having been taken as far east as Maine and as far west as Oregon. This fact coupled with the experience of having once observed a poultry plant suffering tremendous losses and threatened with complete failure due to this pest, moves him to bring to the attention of men engaged in the control of injurious insects the fact that here is an insect which may at any time become a very serious menace to one of the largest phases of agriculture, since it has apparently gained a permanent foothold in the country as evidenced by its range of distribution.

QUESTION: What is the name of the manufacturer?

MR. M. A. STEWART: The Phinotas Chemical Company. I don't know their exact address; I didn't have it in my paper, but Professor O'Kane, or probably any other member of the Board of Governors at the Crop Protection Institute, under whose jurisdiction this work is carried on, can give you the exact address.

PRESIDENT ARTHUR GIBSON: Mr. C. R. Cleveland will present his paper.

STOMACH POISONS FOR CONTROL OF THE SQUASH VINE BORER (*MELITTIA SATYRINIFORMIS* HBN.)[1]

By C. R. CLEVELAND, *Purdue University Agricultural Experiment Station, West Lafayette, Indiana*

ABSTRACT

The squash vine borer (*Melittia satyriniformis* Hbn.) has until recently been considered uncontrollable by the use of insecticides, especially stomach poisons.

Three years experiments at Lafayette, Indiana, indicate that under certain conditions of exact timing and direction of applications, certain stomach poison insecticides give satisfactory and practical control of this insect at low cost.

On the basis of closely compared results from exact observations under identical conditions, Bordeaux 4–4–50-arsenate of lead spray gave the best control, viz., 88 per cent. Adhesiveness is an important factor in effectiveness.

Delayed planting, while effective in preventing infestation, is not practicable, since it results in a crop of uncertain quality or no crop at all.

The squash vine borer (*Melittia satyriniformis* Hbn.) is a troublesome and destructive enemy of squash in central Indiana, and doubtless in other parts of the state as well. Although not an important commercial crop in Indiana, a considerable amount of squash is grown in home gardens and by farmers as a small cash crop.

Repeated attempts in 1922 and 1923 in the entomological experimental garden at Lafayette to grow a small patch of Hubbard squash were complete failures, due to complete destruction of the plants by this borer. This resulted in spite of attempts to control the insect by the time-honored method of slitting the stems and removing the borers and mounding moist soil over the vines. It happened too often that hot dry conditions prevailed at the time of this operation and the vines never recovered from the borers or the operation or both. Late planting fails too often to produce a properly matured crop. Clean up of crop refuse in 1922 failed to save the crop of 1923, the moths probably coming from other nearby breeding grounds.

The problem attracted the writer, partly from a desire to find a control which would enhance his own chances of growing a crop of squash, partly as a means of providing a basis for more satisfactory recommendations to others, and partly from a desire to test the general possibility of spray control for insects of this nature which had not heretofore been considered controllable by the application of stomach poisons.

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[1]Acknowledgment should be made to Mr. G. M. Stirrett for assistance in executing experiments and securing data during a portion of the progress of the investigations.

The squash vine borer hatches from an egg placed usually on the stem of the plant near its base. After hatching the tiny larva must eat its way from the outside through the surface and into the center of the stem. There is then at least a short period in which it must feed on the surface, and probably ingest particles of surface tissue. The period of oviposition and hatching is limited. Likewise the part of the plant attacked is largely restricted to a comparatively limited area. This combination of circumstances seemed to offer a possibility of control by careful, timely and properly directed applications of a stomach poison.

Experiments in Massachusetts (Worthley: Bulletin 218, Massachusetts Agricultural Experiment Station, 1923) apparently resulted in only about 50 per cent control with arsenate of lead spray, while nicotine sulphate, acting probably as an ovicide, secured as high as 100 per cent control. This degree of control, however, was secured only by use of high concentrations (1–100), resulting in a rather excessive cost. Furthermore only one arsenical was tested in the Massachusetts experiments, and nothing is said about the degree of care and effort practiced in securing an even coating of poison on all parts of the plant habitually attacked by the young borers.

It was therefore deemed advisable to inaugurate tests with stomach poisons keeping these various facts and conditions in mind.

Such tests have been conducted at Lafayette, Indiana, for the past three summers, 1924, 1925 and 1926. They have been carried out on a relatively small scale, so far as number of plants and ground are concerned, but the marked and consistent tendency of the results seems to fully justify positive conclusions.

1924 Experiments

Experiments of this year were of a small scale preliminary nature, and results were checked in a less exact and complete manner than in succeeding seasons.

Six plots of winter squash (Hubbard), each consisting of one row of six hills were planted. Each hill was thinned to four plants, so that each plot ultimately consisted of twenty-four plants. The first four plots were planted early, at about the earliest date possible for this section under ordinary practice. Two plots were planted later, as a test of the practical value of late planting for borer control. In addition, one plot of summer crookneck squash was planted early as a trap crop, and as an additional check on the effectiveness of the insecticide treatments employed.

Table 1 records data concerning planting, and treatments for all plots.

No advance schedule of treatments was outlined. Applications were

made, beginning within a period after germination when it was felt the plants would be covered in time to protect against the earliest hatched larvae, and continued as weather and growth conditions made it appear necessary. There were frequent rains during the earlier stages of growth, necessitating a relatively large number of applications. The effort was to keep the plants coated with poison at all times until all reasonable danger of oviposition and hatching was past.

Spray was applied with a hand bucket pump, using a medium fine disk angle nozzle, and special care was used to thoroughly cover all portions of the plants, especially the lower parts of the main stem. The dust treatments were applied with a hand duster of the bellows type in the same manner as the spray.

TABLE 1. PLANTING, GERMINATION AND TREATMENTS, 1924 EXPERIMENTS

Plot No.	Planted	Above Ground		Treatments					
1 Winter (Hubbard)	June 6	June 16		None - Check					
2 Winter (Hubbard)	June 6	June 16	Material	Arsenate of lead spray (1½ lbs. to 50 gals.)					
			No. of applications	1	2	3	4	5	6
			Dates	June 27	June 30	July 5	July 11	July 20	Aug. 2
3 Winter (Hubbard)	June 6	June 16	Material	Arsenate of lead spray (1½ lbs. to 50 gals.)					
			No. of applications	1	2	3	4	5	6
			Dates	June 27	June 30	July 5	July 11	July 20	Aug. 2
4 Winter (Hubbard)	June 6	June 16	Material	Calcium arsenate and gypsum dust (1-20)					
			No. of applications	1	2	3	4	5	6
			Dates	June 27	June 30	July 5	July 11	July 20	Aug. 2
5 Summer (Crookneck)	June 6	June 17		None—Check and Trap Crop.					
6 Winter (Hubbard)	June 20	June 24		None - Late Planting					
7 Winter (Hubbard)	July 11	July 22		None Late Planting.					

TABLE 2. BORER INFESTATION AND INJURY—1924 EXPERIMENTS.

Plat No.	Total No. plants	No. infested	No. uninfested	Per cent plant infestation	No. plants killed	No. plants badly injured	No. plants with some injury	No. plants with no injury
1	24	24	0	100	22	2		0
2	24	2	22	8.3	1		1	22
3	24	0	24	0	0	0	0	24
4	24	0	24	0	0	0	0	24
5	15	15	0	100	0	2	13	0
6	24	0	24	0	All plants badly injured by *D. vittata*, resulting in 100% destruction by Aug. 19. Not reliable for borer records.			
7	24	0	24	0	—	—	—	—

The results in terms of borer control exceeded expectations. Observations were made from time to time as the season advanced, and the progress of infestation, growth and condition of plants recorded. No detailed observations of initial egg infestation, nor of numbers of borers which developed were made during this season. Degree of control secured is represented only by results in terms of number of plants finally showing infestation, and degree of injury shown by the plants in each plot.

Table 2 shows the results as they appeared on the date of final observation, Sept. 8.

Plot 7, planted July 11, apparently entirely escaped borer infestation but very dry weather immediately following germination, prevented growth, and all plants in this plot remained sickly and stunted throughout the season, producing no crop.

Plot 1 produced no crop.

Plots 2, 3 and 4 produced a good crop of marketable squash. Plot 5 produced only three squash of marketable quality.

1925 Experiments

The favorable indications of the 1924 results encouraged further experiments in 1925. Treatments tested in 1924 were repeated, and several other materials were added. Nineteen rows of four hills each, with two to four plants to the hills, in a piece of ground approximately 40 by 150 feet, were used, all of the winter Hubbard variety.

The entire field was first planted on June 13, and the first twelve rows came up June 24; but rows 13–19 failed to germinate, and were replanted June 29, coming up on July 7.

Unfortunately, pressure of other duties prevented close personal supervision of treatments and taking of data in this seasons experiments, and as a result less conclusive evidence was secured. No check plot was provided in the first planting, and since all of the later planting, rows 13–19, entirely escaped infestation, no check consisting of untreated plants was available for comparison with treated plots, where the planting was subject to infestation. Furthermore, through a misinterpretation of instructions, no exact count of borers was made, and no record of the exact number of plants infested and uninfested was kept. However, counts were made of the number of eggs deposited, as well as the resultant hill infestation. This, together with observation of the general condition of plants in all plots, and a rough estimate of the approximate percentage of borer infested and uninfested plants, does give some check on the efficiency of the treatments, and at least indicates a considerable degree of control resulting from their application.

All evidence secured by observations at Lafayette during three seasons work shows a low normal egg mortality for this species. In 1925 six plants, for example, bearing a total of 33 eggs, which were covered with screen wire cages July 2, with a mesh small enough to exclude moths and prevent further oviposition, but large enough to permit the ready entrance of egg parasites, failed to show any mortality, every one hatching, and the resulting borers pentrating the plant and developing to maturity.

Thus, by reference to the number of eggs deposited, and a general observation later as to approximate plant infestation and exact hill infestation, we secure strongly indicative evidence of the effectiveness of the controls tested.

Table 3 summarizes the results in terms of percentage of hill infestation by borers, from observations in August.

TABLE 3. RESULTS OF 1925 EXPERIMENTS

Plot No.	Row Nos	Treatment	No. of hills	Hills infested	Hills not infested	Percentage hill infestation
1	1 2 3	Calcium arsenate and gypsum dust (1-20)	12	5	7	41 +
2	4-5 6	Arsenate of lead (spray) (1½ lbs. powder to 50 gals water)	12	4	8	33⅓
3	7-8 9	Sodium fluosilicate and hydrated lime dust (1-9)	12	3	9	25
4	10-11-12	Arsenate of lead and hydrated lime dust (1-9)	12	3	9	25
5	13	None—check	4	0	4	0
6	14 15	Arsenate of lead and hydrated lime dust (1-9)	8	0	8	0
7	16-17	Sodium fluosilicate and hydrated lime dust (1-9)	8	0	8	0
8	18	Calcium arsenate and gypsum dust (1-20)	4	0	4	0
9	19	None—check	4	0	4	0

Plots 5-9 were the delayed planting, appearing above ground July 7. They showed no infestation either of eggs or borers, indicating that egg-laying had been completed before that date.

While the only exact records of borer infestation were those of hill infestation, the fact that detailed examination from June 24 to July 7 in plots 1–4 showed the presence of eggs on every plant, with an average of three per plant, and that later examination showed many plants and even entire hills in these plots free of borers, indicates a considerable degree of control resulting from the treatment. Plant infestation figures, if available, would doubtless show a considerably lower percentage of infestation than hill infestation figures.

Crop production records showed a fair crop of good quality well matured squashes from Plots 1–4. They show a production of relatively greater numbers and weight from Plots 5–9, but the squashes from these latter plots were mostly immature, and less marketable. One factor favoring heavier production from plots 5–9 was the fact that they were

grown on lower, deeper, richer soil which held its moisture better during dry weather.

It may be said that delayed planting again demonstrated its effectiveness as a borer control measure, but likewise its impracticableness from the standpoint of crop production.

1926 Experiments

Tests conducted during this season were the most exact in point of observation and record, and furnish the most representative and conclusive data of any of the three seasons during which this project was investigated.

Winter (Hubbard) squash was the variety used. They were planted in 8 rows of 10 hills each, with the hills in each row approximately 9 feet apart and the rows 9 feet apart. Rather close planting was necessitated because of lack of space. Each row constituted an experimental plot.

The plan and method of treatment were the same as in previous years. Materials used before were repeated, with one not before tested, Bordeaux and arsenate of lead spray, added. Dust applications were put on with a hand duster of the plunger type. Liquid sprays were applied with an air pressure sprayer equipped with a medium fine angle disk nozzle. Again the greatest care was exercised to thoroughly cover the stems with a coating of insecticide, and applications were made as deemed necessary from the standpoint of rains, plant growth, and the probable seasonal limits of oviposition activity by the moths.

Careful and exact records were made of the number of eggs deposited on the plants, number and amount of spray and dust applications, subsequent plant by plant borer infestation, degree of injury, and crop production.

The infestation proved to be lighter than in past seasons, possibly because of the enforced locating of the plots some distance away from previous plantings. The ground used, was, however, uniform in fertility and texture, providing a more reliable basis for crop returns.

Plots 1–7 were planted on June 9, and came up uniformly and strongly on June 17. Plot 8 was planted July 3 and came up July 12.

Four applications of the various treatments were made on the following dates: June 29, July 8, July 12, and July 14.

Table 4 summarizes the cost of materials per acre, of each treatment for the four applications and the results in terms of percentage of plants infested, number of eggs and borers and percentage of control.

All plants were examined for the presence of eggs on June 22, July 7, and July 10. Results show that maximum oviposition occurred within

TABLE 4. COST AND RESULTS OF 1926 EXPERIMENTS

Plot No.		Cost per acre for four applications	Egg infestation: No. plants infested	No. plants not infested	Percentage infested	No. of eggs
1	Sodium fluosilicate and hydrated lime dust (1–2)	4.36	9	30	23+	19
2	Arsenate of lead spray (1½–50)	1.22	8	28	22+	14
3	Calcium arsenate and gypsum dust (1–20)	3.92	10	35	22+	21
4	Arsenate of lead and hydrated lime dust (1–9)	2.35	11	46	19+	20
5	Arsenate of lead and soap spray 1½–3 50	1.73	11	21	34+	24
6	Bordeaux 4-4-50 and arsenate of lead spray (1½–50)	2.77	15	43	25+	27
7	Check	—	16	35	31+	31
8	Late planting	—	0	60	0	0

Plot No.		Borer infestation: No. plants infested	No. plants not infested	Percentage infested	No. of borers	Percentage control
1	Sodium fluosilicate and hydrated lime dust (1–2)	7	31	18+	10	47+
2	Arsenate of lead spray (1½–50)	8	27	22+	9	36+
3	Calcium arsenate and gypsum dust (1–20)	5	35	12+	6	71+
4	Arsenate of lead and hydrated lime dust (1–9)	6	45	11+	7	65
5	Arsenate of lead and soap spray 1½–3–50	8	20	28+	9	62+
6	Bordeaux 4-4-50 and arsenate of lead spray (1½–50)	3	45	6+	3	88+
7	Check	16	25	39+	31	0
8	Late planting	0	60	0	0	100

the two week period between June 22 and July 7, with some additional egg-laying from July 7 to 10. Further examination on July 13, failed to show any more eggs deposited, and in fact many of those previously observed could not now be found, indicating probable hatching. It should be remembered that 1926 at Lafayette was a relatively late season.

Examination for borer infestation and injury was made on Aug. 5, after all eggs had had an opportunity to hatch and the resulting borers to penetrate the stems. In determining the number of borers in each infested plant fine slits were very carefully made in the stems at points where frass exuded, and the larvae were located and counted, but were not removed. No plants appeared to suffer injury from this operation.

Percentage of control was calculated by comparing borer infestation with egg infestation, assuming practically a 100 per cent hatch in the absence of any treatment. This assumption appears to be reasonably justified because of records from the check plot, which shows 100 per cent hatch and development, and because of observations in the previous two years experiments which indicate a like tendency. There is of course some possibility here of experimental error, but the calculations seem to be closely and relatively reliable at least.

Variation in numbers of plants between the different plots is due partly to the fact that the striped cucumber beetle, which was very severe, killed some plants during the summer, and in fact completely destroyed two hills in plot 5 and one hill in plot 7.

From these results it is quite obvious that some measure of protection was secured with all the treatments applied. Arsenate of lead spray alone gave relatively poor results, sodium fluosilicate and lime very little better, calcium arsenate and gypsum, arsenate of lead and hydrated lime and arsenate of lead and soap only fair control. Bordeaux and arsenate of lead appears rather strikingly more effective, with 25 per cent of its plants originally showing egg infestation and only 6 per cent showing borer infestation and with only three borers out of 27 eggs surviving, giving the treatment a control percentage of 88+.

While an 88 per cent control of this insect is less than must be secured ordinarily under conditions of severe infestation in order to achieve highly satisfactory results in terms of freedom from injury, yet it does provide the margin existing between heavy loss and only moderate injury at least in the case of severe infestations, and indicates the possibilities of this kind of treatment. Further perfection of methods and materials undoubtedly could be accomplished which would yield still more satisfactory results.

Relative adhesiveness of the several sprays and dusts seems to parallel the results quite closely. The Bordeaux spray was most adhesive, traces remaining on the plants long after all signs of other treatments had disappeared. The other materials may be rated downward in respect to adhesiveness about as follows: (1) arsenate of lead and hydrated lime (2) calcium arsenate and gypsum (3) arsenate of lead and soap (4) sodium fluosilicate and lime and (5) arsenate of lead alone. It is not to be assumed from this that adhesiveness of a material is the only deciding factor in its effectiveness. Relative toxicity, repellancy to moths or young larvae or other properties may easily be involved.

Because of the comparatively light infestation in general, no very severe injury was produced, even on the check. However, degree of injury again follows in some measure the results in terms of borer in-

TABLE 5.—DEGREE OF INJURY—1926 EXPERIMENTS

Plot No.	Plants killed	Plants badly injured	Plants moderately injured	Plants slightly injured	Total number plants with some injury
1	0	0	0	7	7
2	0	1	2	5	8
3	0	0	0	5	5
4	0	0	1	5	6
5	0	0	1	7	8
6	0	0	0	3	3
7	1	4	6	5	16
8	0	0	0	0	0

festation and control. Table 5 summarizes this information. Some plants showing infestation had only one borer working at the base of a leaf stalk. In such cases there was no real injury, and they are not recorded.

As in previous years it will be noted that plot 8, late planted, escaped all infestation and injury, but it produced no marketable crop.

Conclusions

From a summary of three years experiments, it appears that the following general conclusions are justified:

1. That a satisfactory degree of control of the squash vine borer may be secured by spraying or dusting with certain stomach poison insecticides.

2. That the degree of control secured is dependent on a combination of several factors, viz. adhesiveness of the materials, timeliness of application, thoroughness of application and care exercised in directing the applications so as to thoroughly cover all parts of the plant most subject to attack during period of hatching.

3. The number of applications necessary to satisfy these requirements appears to be about four, beginning shortly after the plants appear above ground, and continuing for two to three weeks at intervals of about five or six days. These intervals are influenced by weather conditions, especially rain. Heavy rain should always be followed by a repeated application.

4. Of all insecticides tested under identical conditions in the same season, Bordeaux (4–4–50) plus arsenate of lead (1½–50) gave decidedly superior results. However, in 1924, under conditions of greater abundance of the insect, arsenate of lead alone and calcium arsenate and gypsum dust gave a high degree of control, up to 100 per cent. This difference in results between 1924 and 1926 may possibly be explained by greater frequency of early applications in 1924, thus providing better protection during the egg hatching period.

5. Per acre cost for materials, using stomach poison applications, is low, that for the most effective material of 1926, being only $2.77 for four applications. This cost is much below that for the only other insecticide treatment heretofore showing effective results, viz. nicotine sulphate.

6. Late planting, while effective in borer control, is not practical for central Indiana, resulting in poor maturity of the crop.

Adjournment: 12:15 p. m.

Thursday Afternoon Session, December 30, 1:30 p. m.

First Vice-President C. J. Drake presided.

FIRST VICE-PRESIDENT C. J. DRAKE: The first paper this afternoon is by D. T. Ries.

THE APPLE MAGGOT IN MICHIGAN

By DONALD T. RIES, *Michigan State College*

ABSTRACT

The Apple Maggot (*Rhagoletis pomonella* Walsh) has once more been causing severe losses in Michigan after a dormancy of about a quarter of a century. The adults appear in July and are at large until near the end of August. The larvae leave the fruit soon after it falls to the ground and enter the ground to pupate. About one-third of these emerge in September forming a second brood of flies that oviposit in late winter apples. Others may possibly lie over in the soil two years before emerging.

The Apple Maggot or "railroad worm" (*Rhagoletis pomonella* Walsh) during the past few years, has again become a serious problem to the fruit-growers of Michigan, after an absence of about quarter of a century. The damage in 1925 was not confined to small isolated areas but was quite generally distributed thruout the apple-growing regions of the state. In 1926, however, the more serious ravages seemed to be confined to one or two localized areas.

This insect was first reported from Michigan by Prof. A. J. Cook as doing great damage to the apples in Shiawassee County in 1884. For a number of years it was recorded as causing a large amount of damage to the apple crop. About 1900 the ravages seemed to decrease and very little was heard or seen of the pest until 1924 when it again began causing losses, and in the following year, 1925, nearly all the orchards of the state were quite heavily infested with the maggot.

In 1925 work was started on the life history of this insect. This was continued and completed this year and the new facts found are presented in this paper.

In the fall of 1925 we found the flies present in large numbers in the orchards at Stockbridge, Michigan as late as the first week in September. These flies were ovipositing in the late winter apples. At picking time the apples showed no evidences of the maggots working within them, but when the fruit was taken from storage for the market the flesh was found to be tunnelled thruout by the maggots, making it unmarketable. What happened to the puparia that must have formed from the maggots in these apples we were not able to ascertain. Probably many perished thru drying up as moisture was found to be needed by them.

The adult flies were first observed emerging on July 13th this year. At that time only a few were found in the different orchards. The general emergence began on July 15th and the flies continued to be abundant until the 23rd of August. On September 27th a few adults were found crawling among the fallen apples beneath a Maiden Blush tree. The weather was too cold for them to take flight and infest the nearby winter apples. These were probably adults of the second generation which in some years would infest the winter apples.

The first oviposition was observed on August 2nd, but upon cutting into the fruit a number of very young larvae were found, indicating that oviposition started a number of days before. It seemed from observations made of caged specimens that it takes about two weeks after the adults emerge for the reproductive organs to reach maturity. The eggs are laid just beneath the surface of the skin in a small cavity that is made at an angle of about 45° by means of the ovipositor. A little over a minute was required for oviposition. When first made, the punctures are inconspicuous, but soon turn dark, leaving a small brown speck on the surface of the fruit. Most of the eggs are laid on the sides rather than on the ends of the fruit.

When the fruit begins to grow and enlarges in size these spots many times appear as dimples and are sometimes confused with the injury of the Apple Redbug, Aphids, or Apple Seed Chalcid.

The incubation period lasted from two to seven days in Michigan—depending upon the temperature and variety of the apple. In early apples, Yellow Transparent, Early Harvest, etc., the eggs hatched in two or three days; while in later apples, McIntosh, Hubbardston, Grimes Golden, etc., six or seven days were required. The length of the larval period also seemed to vary with the variety of the apple; 13 to 15 days in Yellow Transparent, while in Pound Sweets 27 days were required to complete the larval period. Eggs deposited in Stark's Delicious on August 23rd were examined on October 9th and only very small larvae were found. None had as yet left the fruit. On November first the larvae were about half grown.

In most cases the presence of the maggots causes the fruit to ripen prematurely, drop to the ground and decay. This was not true, however, in the case of Greasy Pippins, which were found heavily infested and the emergence holes of the larvae were found in the sides of the decaying apples still hanging on the tree.

Soon after the fruit drops to the ground, the larvae leave and enter the soil where pupation takes place. Several writers advocated picking up the "drops" twice a week in an attempt to keep a large portion of

the larvae from going into the soil. This method, however, did not prove effective this past season in Michigan. In the case of several trees of Early Harvest Apples the orchard was visited on Tuesday, at which time 178 apples were picked up. These apples had fallen since late Sunday afternoon. Of these 178 apples, 163 were found to contain either maggots or evidences of maggots having been present, and 125 of this latter number contained exit holes of the maggots. so it would seem that the larvae had left the fruit very soon after the fruit had reached the ground as there were no exit holes found in the apples still remaining on the tree. It was also found that some of the maggots may pupate in the tunnels within the fruit.

It was thought that the maggots that entered the ground this year remained there over the winter and emerged the following spring. On August 3rd two cages were "made up," one in the greenhouse and one out doors, containing a number of Yellow Transparent apples. On September 19th, 2 males emerged from the material in the greenhouse cage and two days later, September 21st, several males and females emerged from the cage out doors. Adults continued to emerge from these cages until October 9th. It seemed that about one-third emerged to form the second generation.

It also seems probable that some of the puparia lie over for two years instead of emerging the following spring. The reason for suspecting this is the fact that in one orchard there was a heavy infestation in 1924. In 1925 the flies were again plentiful, but the orchard was very carefully sprayed and all the "drops" picked up daily and completely disposed of by burying in a deep hole that was treated with kerosene and lime before it was closed up; yet in 1926 we again found quite a heavy infestation that probably came from the orchard itself as it was isolated from others and from observations made this past season the adult flies do not seem to fly a very great distance.

First Vice-President C. J. Drake: The next paper is by P. J. Parrott.

THE PEACH COTTONY SCALE

By P. J. Parrott and S. W. Harman

Abstract

The resistance of the peach cottony scale (*Pulvinaria amygdali ?*) to common sulfide sprays prompted efforts to determine the susceptibility of the insect to oil sprays. Tests demonstrated the possibility of securing satisfactory commercial

control with various oil preparations applied in the spring as the buds were swelling as well as with midsummer applications of "white oil emulsions" directed against "crawlers" and young scales. It is noted that plantings receiving either two or three treatments with "white oil emulsions" for two successive years have so far shown no indications of injury to the health of the trees.

During the summer of 1925 peach growers were thrown into a flutter on account of the appearance in their plantings in considerable numbers of an unfamiliar scale insect. A survey of the area of infestation showed that the species was most conspicuous in peach orchards within a range of 5 to 7 miles of the shore of Lake Ontario in Wayne, Monroe, Orleans, and Niagara counties. In view of the conspicuous infestation of certain orchards and the resulting perturbation among growers, it is worthy of note that, with one possible exception, the pest if present on the trees during 1924, and it surely must have been, completely escaped the attention of orchardists and county and state officials in the agricultural service. With this fact in mind it is not hard to picture the surprise of all those who were in any way concerned with the welfare of the peach industry as they reflected on the widespread distribution and the all too obvious destructive capacities of an apparently unknown insect.

On the assumption that a new pest was involved questions which naturally suggested themselves were. "What was the native habitat of the pest? How did it find its way to this area? What was the history of the species in the fruit region prior to its discovery? What was the most practical method of saving the peach crop already showing evidences of serious smutting?" To these questions there were no definite answers—only surmises. Superficial observations of the insect indicated a close similarity to the maple cottony scale, *Pulvinaria vitis*, but one's confidence in such a diagnosis was rudely jarred by a subsequent survey of the infested region which revealed that, while several maple trees showed a few specimens of this scale, maples generally were free of infestation. In marked contrast to the condition of maples one experienced little difficulty in finding infested peach orchards in the area described, and since it seemed to meet practical needs the insect was therefore tentatively designated as the "peach cottony scale." Coming as it were over night, such was the problem presented to us for solution

THE IDENTITY OF THE PEACH COTTONY SCALE. It was obviously desirable to have the species correctly identified and, accordingly, specimens were forwarded to systematists specializing in this group of insects. At present the determination of the scale is still uncertain. It has been identified as *Pulvinaria amygdali*, previously reported on peach from New Mexico; on plum from South Carolina, Georgia, and

California; and on prune from California. Likewise, the insect has been classified as *Pulvinaria vitis* which, as is generally known, is our common maple cottony scale reported to have a wide range of host plants, including the peach. Specimens of *amygdali* from Georgia and California show differences from the form occurring on peach trees in New York which make us think that a different species is involved. On the other hand, the insect more nearly resembles *vitis*. If not this species, our form is apparently closely related to it. The systematists are devoting their attention to this aspect of the problem.

HOST PLANTS. The cottony scale occurs commonly on peach trees. It has also been observed in goodly numbers on quinces, plums, and prunes. Apparently the pest thrives on all three hosts, notably quinces, which in some instances were as heavily incrusted as peach trees. Apple and pear foliage in close proximity to peach plantings frequently showed large numbers of "crawlers" and young scales, but, generally speaking, the insect seems to have found it difficult to establish itself on these plants. Several reports were current that the scale was observed on grape and woodbine, but no cases of infestation were brought to our attention. While the pest breeds freely on several peach varieties, it is deserving of note that a surprisingly large number of failures characterized our attempts to colonize the larvae on a variety of peach different from the one from which they had been transferred.

LIFE HISTORY. The life and habits of the peach cottony scale correspond closely with those recorded for *P. vitis*. The number of eggs varied with individual scales, apparently due in part to differences in the maturity of the creatures, and ranged from 800 to as high as 3,000 and upwards per insect. Because of the interest in white oil emulsions which were used effectively against the crawlers and young scales, as will be considered later, it should be noted that during 1925 the eggs began to hatch by the middle of June and that hatching was apparently completed by the first of July. The season of 1926 was at least two weeks behind the 1925 season, due to a late spring and cool summer, and hatching did not start until July 1 and was concluded on July 27. Making some allowance for differences in seasonal conditions, the period of these activities is quite similar for that reported previously for *vitis* from both New York and Ohio.

NATURE OF INJURY TO PEACHES. Plantings which show noticeable infestation usually display lack of vigor, due to the weakening and unseasonable shedding of the leaves and the occurrence of dead twigs and branches. Another source of loss which is perhaps more keenly felt by growers than the depleted state of health of the trees, since it is so

obviously connected with the season's financial returns from the orchard, is the smutting of peach fruits. Blackened peaches become increasingly difficult to market at satisfactory prices when once the true nature of their discoloration is generally understood by fruit buyers. In packing peaches for the higher grades the specifications require the rejection of all smutted specimens, in consequence of which there may be considerable disparity between the yield of the orchard and the volume of marketable fruit.

A NATURAL ENEMY. A common parasite of the peach cottony scale is the hymenopteron, *Coccophagus lecanii*, which was kindly identified by Mr. S. A. Rohwer, U. S. Bureau of Entomology. The effective work of this parasite, coupled with the high mortality of the hibernating forms, seems to warrant the opinion that the cottony scale will not prove to be a permanent pest of primary importance.

CONTROL OF SCALE WITH OIL EMULSIONS. Lubricating oil emulsions (cooked and cold mixed) and proprietary miscible oils, diluted with water to give an oil content of 4 per cent, have afforded efficient protection. Fall applications appear to be as effective as spring treatments. In contrast with the oil sprays, lime-sulfur 1 to 8 was noticeably inferior. No injury was observed from oil mixtures of the foregoing strength when the applications were made during the period when buds began to swell and before the green tips showed, providing freezing weather was avoided.

Also, the scale proved susceptible to summer applications of commercial white oil emulsions (Volck and Medina) containing 2 per cent oil, and to home-made "white oil emulsions" containing "white mineral" oil and "Petrolatum Medium" (Nujol). The eggs were resistant to mixtures containing not more than 2 per cent oil.

"Crawlers" and young scales were very susceptible to these preparations. On account of the interference of the foliage careful spraying is required in the summer treatment, special pains being exercised to reach the scales on the under sides of the leaves. Effective control of the pest was secured in severely infested orchards with two applications, the first treatment being made when the "crawlers" first made their appearance, and the second treatment at the conclusion of the hatching period. Two applications of the "white oil emulsions," commercial or home-made, have apparently caused no injury to the trees. Moreover, one planting receiving three such treatments in 1925 and two applications during 1926 has so far revealed no ill effects. What the ultimate result will be from repeated treatments over a period of years is a matter for the future to determine. So far, the "white oil emulsions" have proved to be the only oil sprays that were safe to peach foliage. Injuries to

leaves occurred only when white oil emulsions were used in combination with copper or sulfur compounds or when they were applied to trees that had been previously treated with sulfur mixtures.

FIRST VICE-PRESIDENT C. J. DRAKE: We will now listen to a paper by Alfred Weed.

METAMORPHOSIS AND REPRODUCTION IN APTEROUS FORMS OF *MYZUS PERSICAE* SULZER AS INFLUENCED BY TEMPERATURE AND HUMIDITY[1]

By ALFRED WEED,[2] *University of Wisconsin*

ABSTRACT

Life history studies of the species have been carried in a series of controlled chambers in which the temperature and humidity have been constant. Interesting data has been accumulated with reference to length of instars, longevity and fecundity as inhibited or stimulated by a prescribed environment. The retardant influence of low temperature and humidity on the rate of development and reproduction of the species, together with the corresponding acceleration, which increases in these factors of the environment bring forth, are clearly indicated in the tabular and graphical presentation of the results.

INTRODUCTION. In the field of biological science the restrictions placed upon living organisms, both plant and animal by environmental factors are obvious. These factors are ever present, and change both in quality and quantity from day to day, with a correlated response in the organisms. The character of the response depends upon the extent and degree of change of the environmental factors, and the susceptibility of the individuals under observations. Temperature and humidity are both important, because of the influence they exert upon metabolism and the physico-chemical phenomena of life.

The data presented represents the study of some three hundred individuals carried thru the winters of 1925 and 1926 in the greenhouse, as well as in chambers in which the temperature and humidity were maintained constant. Life history studies on apterous individuals supplied the data; and under the environmental conditions provided these forms continued as a constant, altho the species was subject to variations in temperature of eighteen degrees Centigrade (from 10°–28°) and twenty-five per cent relative humidity (from 60%–85%).

THE NATURE OF THE CHAMBERS. Conditions in the greenhouse were

[1]Contribution from the Department of Economic Entomology.

[2]Thanks are extended to Doctor J. G. Dickson for the use of the controlled chambers in which the studies were conducted.

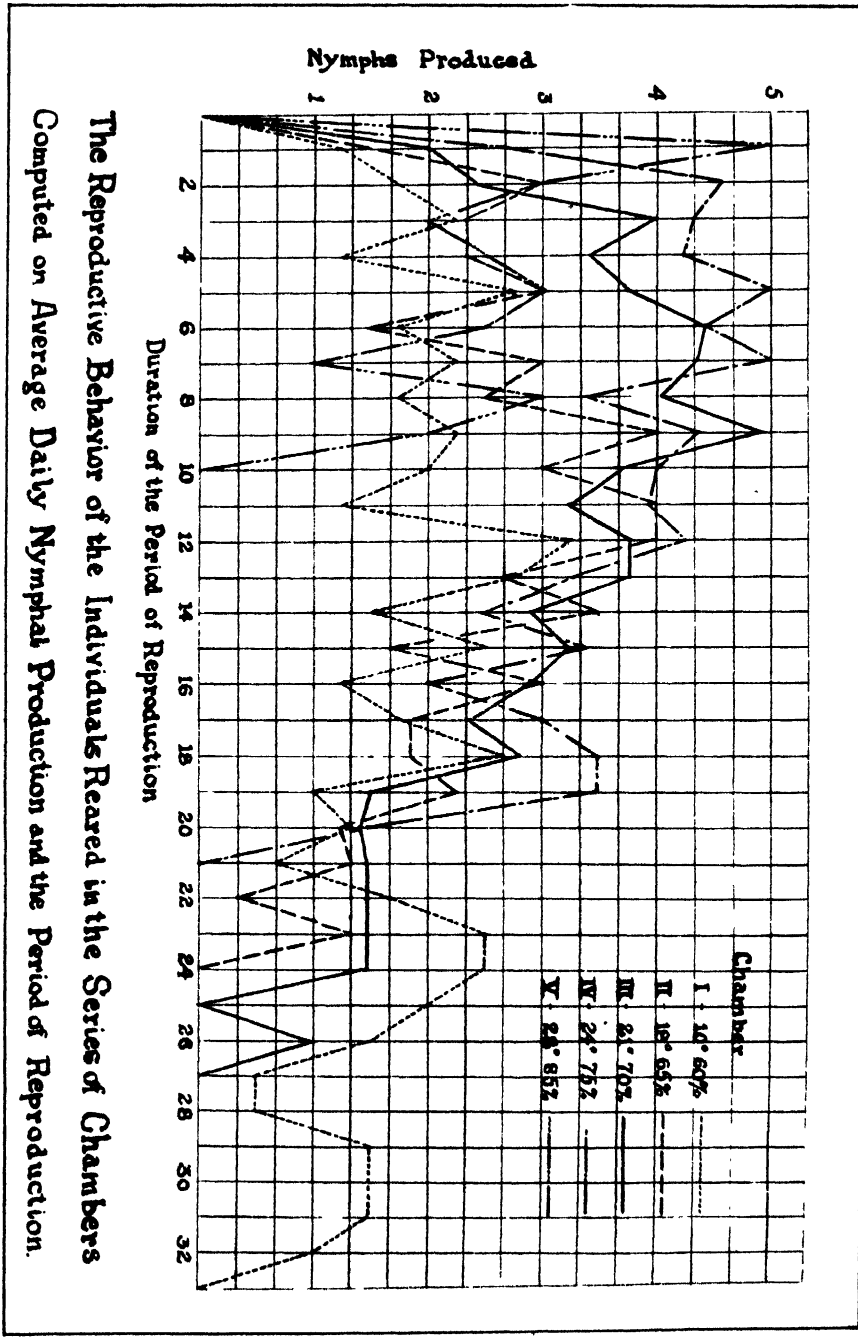

Nymphs Produced
1
2
3
4
5
Duration of the Period of Reproduction
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
Chamber
II · 18° 65%
III · 21° 70%
IV · 24° 75%
The Reproductive Behavior of the Individuals Reared in the Series of Chambers
Computed on Average Daily Nymphal Production and the Period of Reproduction.

Fig. 6

somewhat comparable to those out-of-doors; but the variations never reached the maximum or minimum temperature and humidity common in the field. The average temperature in the greenhouse, given in the tables as Chamber No. 3, approximated 21° Centigrade and the relative humidity ran at 70%.

The controlled chambers,[3] which were used in connection with the life history studies, consisted of large glass compartments, situated in separate sections of one of the (Plant Pathology) greenhouses. A cooling system of sulfur dioxide and brine, electric heating units, and humidifying equipment maintained uniformity in both temperature and humidity. The conditions maintained within the chambers were approximated in the compartments housing them. Hygrothermographic records, taken within the chambers denoted the changes to be made in the control apparatus. Average conditions in these chambers ran as follows: Chamber I, temperature 10° Centigrade, relative humidity 60%; Chamber II, temperature 16°, humidity 65%; Chamber III (greenhouse), temperature 21°, humidity 70%; Chamber IV, temperature 24°, humidity 75%; Chamber V, temperature 28°, humidity 85%.

METHODS. Two types of cages were employed in conducting the life history studies; standard battery jars, and ordinary lamp chimneys. With the cages mentioned, large-mouthed bottles of convenient size were used to provide an adequate supply of water for leaves of spinach upon which the aphids were reared.

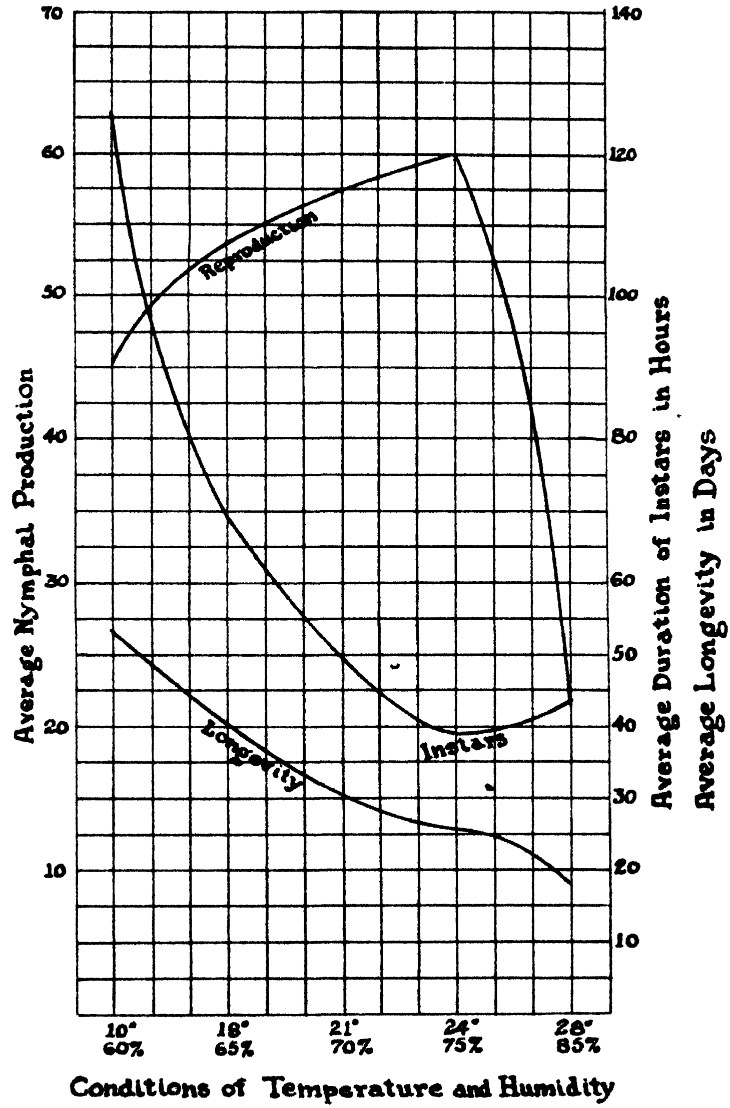
In the greenhouse both types of cages were used, but in the controlled chambers where limitations of space were incurred, only the latter type of cage was employed.

Blackened metal discs, several inches in diameter and provided with a central perforation to accommodate the plant stems, were fitted into the necks of the bottles in the battery jars. These discs facilitated both the recording of the cast skins and prevented individuals from dropping to the bottom of the cage. The central perforation was plugged with cotton after the leaf was in place. This prevented the drowning of individuals and the loss of nymphal skins. A cheese cloth cover, held in place with rubber bands, completed the structure of the cage.

The "chimney" cages were essentially the same, except that the globes were inverted and fitted with cardboard bottoms. The wide-mouth bottles were held upright by surrounding them with cotton wadding; and black cardboard discs were used.

The individuals under observation were maintained on fresh leaves

[3]Dickson, J. G. Making Weather to Order for the Study of Grain Diseases, Wisc. Agr. Exp. Sta. Bull. 379, 1926.



Curves - Illustrating the Influence of Temperature and Humidity on Reproduction, the Length of Instars and Longevity in Myzus persicae Sulzer.

Fig. 7

of spinach, cut under water, to prevent air from entering the conductive vessels of the stems. Fresh material was supplied at forty-eight hour intervals; and the stems were cut back every twenty-four hours. The aphids were always handled with extreme care, transfers being made with a fine camel hair brush. Observations were made twice daily upon the nymphs and the adults; and the first and last born nymphs were reared thru to maturity; they and their progeny being employed for a continuation of the studies.

RESULTS. The results are illustrated in the tables and the accompanying graphs; and indicate the differences in the activities of the species as stimulated by temperature and humidity. That these differences are restricted within certain limits of temperature and humidity is obvious, for in one of the Chambers (V), the individuals showed signs of inhibition. The general effects of these factors on reproduction, the duration of instars and on longevity, as characteristic for the chambers are shown in the series of curves. (Fig. 7.) In plotting the curves, the average reproduction, the average length of the instars and the average longevity, for all the individuals studied, have been taken for each of the five chambers.

METAMORPHOSIS. These results show that metamorphosis is directly influenced by changes in temperature and humidity. Individuals reared under identical conditions, even from the same parent, responded quite differently to the environmental conditions. An examination of Table 1, showing stages in metamorphosis indicates clearly the retardant nature of the lowest chamber and that the gradual speeding up of this process is correlated with increase in temperature and humidity. Conditions in Chamber V were apparently inhibitory to the development of the species. In this chamber difficulty was experienced in carrying individuals thru to maturity. Altho the maximum and minimum duration of the instars was identical in some of the chambers, computations giving the averages show a diminution in the lapse of time between molts with increases in temperature and humidity. A shortening in the length of the immature stages and a decrease in the time element between maturity and the production of the first nymphs is shown.

The averages assumed are based upon computations for the entire number of individuals reared under the various conditions of environment, and no consideration is given to the generations concerned. However, it may be stated that all the results computed begin with the 2nd filial generation.

REPRODUCTION. Reproduction, like metamorphosis, is also influenced by changes in temperature and humidity. An increase in the nymphal

production is seen in the chambers in which the temperature and humidity were high. Considerable variation is incurred when the maximum and minimum nymphs per individual are examined. This acceleration of reproduction is evidenced in the average total nymphs produced and in the daily averages based upon both the reproductive period and adult longevity. Certain forms in Chambers II and III appear subnormal with reference to their reproductive ability and may possibly have been injured to some degree; but a correction was not made because their longevity was comparable to others under the same conditions. As in the metamorphic stages, Chamber V, exhibited its retardant effects upon reproduction.

Figure 6, illustrates the average daily reproduction computed for the total number of individuals in each chamber. It is interesting to note that the maximum period of reproduction by individuals was reached first under conditions of higher temperature and increased humidity. In Chamber V, temperature 28°, humidity 85%, this is reached the first day, after which reproduction decreases. In Chamber IV, temperature 24°, humidity 75%, the peak extends from the fifth to the seventh day; while in Chamber III, temperature 21°, humidity 70%, it is reached on the ninth day. In Chamber (II), temperature 16°, humidity 65%, it appears from the ninth to the twelfth day, whereas in Chamber I, temperature 10°, humidity 60%, the peak is reached on the twelfth day.

Reproductive Period and Longevity. The reproductive, nymphal, and adult period, and the total period of longevity indicate the reverse effect of temperature and humidity. A decrease in these stages of the life cycle is associated with increases in the factors under consideration. The average reproductive period drops from twenty-five and one-fourth days in Chamber I, to seven days in Chamber V. The latter chamber plainly inhibits the development of the species. The average total longevity of the species in Chamber I is nearly sixty days. This falls to less than eighteen in Chamber V. Nymphal and adult longevity periods indicate parallel diminutions in the time factor with increases in temperature and humidity.

Conclusions. There is a definite response in *Myzus persicae* Sulz. to changes in temperature and humidity. An increase or decrease in temperature and humidity acts as a stimulus. Increased activity is brought about by rises in temperature and humidity but when temperatures near 28° and humidity near 85% are reached, inhibition occurs. The converse occurs with extreme low ranges.

With an increase in temperature and humidity there is an increase in the rapidity of growth, and a speeding up of the process of repro-

TABLE 1. METAMORPHOSIS

Chamber	Individuals	Hours between birth and 1st molt			Hours between 1st and 2nd molts			Hours between 2nd and 3rd molts			Hours between 3rd and 4th molts			Hours between birth and maturity			Length of instars in hours			Hours between maturity and prod. of 1st nymphs		
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.
I 10°-60%	16	192	48	126.00	144	96	120.00	144	120	126.00	168	120	129.00	624	456	501.00	192	48	125.25	144	48	86.40
II 16°-65%	22	96	48	75.27	96	48	67.63	120	48	60.00	120	48	70.90	360	192	273.80	120	48	68.45	72	12	34.66
III 21°-70%	138	72	24	47.44	72	24	49.21	72	24	48.34	72	24	54.96	240	144	199.95	72	24	49.98	72	12	27.15
IV 24°-75%	67	72	24	39.04	72	24	38.33	72	24	34.03	72	24	44.42	192	120	155.82	72	24	38.95	48	12	22.00
V 28°-85%	8	48	24	36.00	48	48	48.00	48	24	36.00	72	48	54.00	192	168	174.00	72	24	43.50	48	12	24.00

TABLE 2. REPRODUCTION AND LONGEVITY

Chamber	Individuals	Actual reproduct. Period in days			Young produced daily: Average based on Reproductive period	Average based on Adult longevity	Max.	Min.	Total			Longevity in days: Nymphal			Adult			Total		
		Aver.	Max.	Min.					Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.
I 10°-60%	12	25.25	32	17	1.79	1.45	5	1	45.25	57	36	21.66	26	19	31.25	41	26	52.91	61	46
II 16°-65%	18	20.50	26	15	2.62	1.88	8	1	53.83	83	16	12.10	15	8	28.50	41	19	40.60	53	31
III 21°-70%	36	17.66	24	10	3.23	2.56	10	1	57.11	85	18	8.38	10	6	22.28	41	11	30.66	48	19
IV 24°-75%	24	16.00	20	12	3.72	3.00	10	1	59.62	75	40	6.23	8	5	19.87	30	13	26.00	37	20
V 28°-85%	12	7	9	5	3.07	1.95	8	1	21.5	37	6	7.33	8	7	10.50	14	8	17.83	20	14

duction. With these conditions the greatest number of individuals are produced, not only on a daily basis but also for the life of the individual and the time requirement for the newly born nymph to reach maturity is materially lessened.

With a diminution of temperature and humidity, reproduction is inhibited and the rapidity of metamorphosis is reduced. Also, reproduction persists for a greater duration of time and the individuals live considerably longer.

It appears from the data that in *Myzus persicae* Sulz. the processes of metamorphosis, reproduction and longevity are proportional to temperature and humidity. An increase in reproduction and diminutions in the length of nymphal instars and longevity are correlated with increases in temperature and humidity, and the reverse is quite apparent with decreases in these environmental factors. This of course applies only within those ranges of temperature and humidity which are not harmful to the species.

First Vice-President C. J. Drake: The next paper is by E. D. Ball, B. L. Boyden, W. E. Stone and J. E. Reeves. Dr. Ball will read the paper.

BIOLOGICAL FACTORS IN THE CONTROL OF THE CELERY LEAF TYER

By E. D. Ball, B. L. Boyden, W. E. Stone and J. E. Reeves, *Sanford, Florida.*

(Withdrawn for publication elsewhere)

Mr. G. W. Herrick: I would like to ask Dr. Ball if he determined the number of caterpillars any one bird will eat.

Mr. E. D. Ball: No I did not. The moths flying out of the celery would be caught by the birds so the caterpillar crop fell down to the minimum. The birds would sit on the boxes where the harvesters were getting ready to harvest the celery and every time a moth appeared above the level of the celery it was gone.

First Vice-President C. J. Drake: The next is a paper by T. J. Headlee.

AN OPERATION IN PRACTICAL CONTROL OF CODLING MOTH IN A HEAVILY INFESTED DISTRICT[1]

By Thomas J. Headlee, Ph.D., *Entomologist, New Jersey Agricultural Experiment Station*

Abstract

This paper gives the results of one year's effort against the codling moth, *Carpocapsa pomonella*, carried out by a group of eleven growers associated for that purpose and cooperating with the entomologist of the New Jersey Agricultural Experiment Station and shows: (1) that under codling moth infestation conditions, indicated by the fact that the late fruit in the check orchard averaged five injuries per apple, 73,850 bearing apple trees, covering 1,376 acres of orchard land, produced 280,200 bushels of fruit of which 192,320 bushels, or 68.8%, were absolutely free from all codling moth injury; (2) that this percentage of 68.8 represents a 20.5% increase in fruit absolutely free from codling moth injury over the conditions obtaining the previous year; (3) that the maximum amount of fruit absolutely free from codling moth injury at picking time obtained on any one of these properties was 97%; (4) that the principal factors underlying this accomplishment were more timely and accurate spray applications and the more intelligent and careful use of orchard sanitation measures, such as scraping the rough bark from the tree, the utilization of burlap bands and the partial or complete elimination of the used containers as a source of codling moth infestation. The conclusions are: (1) that, under the local conditions of heavy infestation of codling moth, this insect can be suppressed by intensive work against it; (2) that the most intensive part of the effort is the cover spray program against the entering larvae of the first brood; (3) that, where the insect has been suppressed, a very high percentage of the picked fruit can be brought through absolutely free from codling moth injury by intensive work against the first brood only.

Codling moth in a certain district of New Jersey has shown in the past thirteen or fourteen years a very great increase in destructive power. In fact, at the close of 1925 it had reached a point where some growers were beginning to believe that it could not be brought under control by any practicable means. This being the case it seemed well to attack the problem in this worst infested district.

Causes of Increase. The reasons underlying this increase in infestation are more or less obvious to anyone who makes a study of the problem. First of all, for some unknown reason, parasites of the codling moth have in that district reached a very low stage of efficiency. In the second place the habit of storing used baskets in buildings, either in or nearby the orchard, has obtained for a number of years. In these used baskets large numbers of codling moth larvae have spun up and from them the adults have emerged each spring. In the third place the

[1]Paper No. 334 of the Journal Series of the New Jersey Agricultural Experiment Stations, Department of Entomology.

orchards in this district have come into bearing slowly, probably due to the lack of proper pollinizing. The crops were small and were not economically worth adequate treatment but still sufficiently large to offer the codling moth an abundance of food on which to grow and increase.

Be the causes of increase whatever they may, the moth several years ago had reached the point where it was capable of destroying every example of late fruit borne by unsprayed trees and capable, under the methods of treatment obtaining, of infesting entirely too large a percentage of the fruit borne by treated trees.

ORGANIZATION FORMED. Early last spring an organization of eleven growers was formed for the purpose of seeing what could be done toward reducing codling moth damage in this the Glassboro district. The Experiment Station representative agreed to specify when to treat, what to treat with, and how to treat. The growers agreed to equip themselves and carry out these directions to the best of their ability. Since this effort under this organization covered more than one thousand acres of bearing fruit in the worst infested section of the Glassboro district, it was felt by the Experiment Station that much time and trouble would be justified in carrying out this plan.

Accordingly, starting with the first sprays, the entomologist, with the exception of two or three occasions, visited each orchard property included within the group once each week throughout the season until about the middle of August, when the treatment effort had obviously come to an end.

TREATMENTS ADVISED. The treatments advised during the season covered: (1) the scraping of all old rough-barked trees in such a fashion as to clean off the rough bark and the application and working of burlap bands; (2) the removal or adequate treatment of used baskets normally placed in storage within or adjacent to these properties; (3) a spray schedule consisting of delayed dormant, pink bud, blossom fall, seven day after blossom fall, intensive cover sprays during the period of entry by the worms of the first brood of codling moth and a small number of cover sprays during the period of entry by worms of the second brood. In this instance the scarcity of apple aphis eggs and the abundance of European red mite eggs led to the use of a delayed dormant spray consisting of oil emulsion. The pink bud spray consisted of the same materials usually recommended, namely, commercial lime sulfur and lead arsenate. The blossom fall spray consisted of dry-mix and lead arsenate according to the usual formula. The seven day after blossom

Table 1. Record of Codling Moth Control in 1926

Concerns the Properties of Growers Associated for Control of Codling Moth at Glassboro

Orchard number	Acreage	No. of trees	Size of trees height x width in feet	Per cent fruit Early	Per cent fruit Late	Number of sprays Early Total	Number of sprays Early Codling moth	Number of sprays Late Total	Number of sprays Late Codling moth	Average number of gallons per tree per treatment	Scraping Needed	Scraping Used	Banding Needed	Banding Used	Yield in bushels	Per cent free from codling moth injury 1925	Per cent free from codling moth injury 1926	Gain
1	80	2,400	20 x 25	35	65	6	3	8	5	8	Yes	Late Yes Early No		Late Yes Early No	28,000	50	75	25
1A	130	7,000	20 x 25	7	93			7	4	8	Yes	No	Yes	No	13,000	55	50	—5
2	25	700	25 x 30					7	4	8	Yes	No	Yes	No	6,000	25	40	15
2A	25	700	12 x 14		100			9	6	3	No	No	?	Yes	4,000	40	85	45
3	100	5,000	20 x 25		100			9	6	9	Yes	No	Yes	Yes	65,000	45	60	15
3A	30	1,500	20 x 25		99			7	4	3.6	Yes	No	Yes	Yes	15,000	50	75	25
3B	15	800	25 x 30					7	4	5?	Yes	No	Yes	No	5,000	00?	85	85
4	35	2,000	16 x 18	10	90			9	6	5	Yes	No	Yes	Part.	6,000	40	70	30
5	15	1,200	12 x 14	13	87	2	1	9	6	2¼	No	No	Yes	Yes	4,000	45	85	40
6	60	3,000	20 x 25	20	80	6	3	8	5	3	Yes	No	Yes	No	12,000	60	85	25
7	15	900	16 x 20	10	90	4	2	8	5	4	No	No	Yes	Yes	3,200	60	90	30
8	400	15,000	20 x 25	25	75	6	3	8	5	7	Yes	Late yes	Yes	Yes	55,000	35	50	15
9	80	3,850	20 x 25	20	80	6	3	8	5	7	Yes	No	Yes	No	14,000	39	75	36
10	40	1,800	22 x 28	5	95	6	3	8	5	5.0	Yes	Yes	Yes	Yes	10 000	75	80	5
10A	50	3,000	25 x 30	25	75	6	3	8	5	6.6	Yes	Yes	Yes	Yes	23,000	80	95	15
11	276	25,000	10 x 12		100			7	4	2.5	No	No	No	No	17,000	60	97	37
Totals	1376	73,850													280,200			

Note:—Check orchard was sprayed according to its owner's judgment Some clean fruit came from early varieties. Late varieties averaged 5 stings per apple. Orchards Nos. 1A and 2 were admittedly very inadequate from the standpoint of time of application.

fall spray consisted of the same material. The cover sprays for the first brood side worms consisted of dry-mix with powdered lead arsenate at the rate of two pounds to fifty gallons or its equivalent and enough additional sticker to make a total of three pounds to one hundred gallons, and the cover spray of the second brood consisted of a reduced amount of dry-mix, no additional sticker and lead arsenate with the usual strength of one and one-half pounds of the powder to fifty gallons. The timing of the cover sprays was made through the agency of the codling moth emergence cages and codling moth bait pans. As soon as the cover spray stage was reached it was insisted by the entomologist that the sprays should result in a film coating of fruit and foliage and that they should be repeated with sufficient frequency to insure the maintenance of this coating. Of course, on early fruit fewer cover sprays were given, and these without additional sticker, than the number given to late fruit for the same stage of the codling moth. All spraying was stopped the middle of August.

Results of Treatment. The results of the effort are set forth in three tables which are self-explanatory.

Table 2. Record of Yields Under Treatment for Codling Moth Control 1926 Concerns the Properties of Growers Associated for Control of Codling Moth at Glassboro

Orchard numbers	Yield in bushels Total	Fruit free from codling moth Bushels	Per cent	Gain in 1926 fruit free from codling moth as compared with 1925 Per cent	Bushels
1	28,000	21,000		25	7,000
1A	13,000	6,500		—5	—650
2	6,000	2,400		15	900
2A	4,000	3,400		45	1,800
3	65,000	39,000		15	9,750
3A	15,000	11,250		25	3,750
3B	5,000	4,250		85	4,250
4	6,000	4,200		30	1,800
5	4,000	3,400		40	1,600
6	12,000	10,200		25	3,000
7	3,200	2,880		30	960
8	55,000	27,500		15	8,250
9	14,000	10,500		36	5,040
10	10,000	8,000		5	500
10A	23,000	21,850		15	3,450
11	17,000	16,490		37	6,290
Totals	280,200	192,820	68.8	20.5	57,690

Note:—Removing orchards Nos. 1A and 2 from consideration because they are clearly and definitely inadequately treated we have the following results:

	266,200	195,420	73.4	25.2	67,190

TABLE 3. BRIEF GENERAL SUMMARY OF CODLING MOTH CONTROL IN 1926 CONCERNS THE PROPERTIES OF GROWERS ASSOCIATED FOR CONTROL OF CODLING MOTH AT GLASSBORO

A. Including all orchards regardless of treatment obtained	
No. of orchard properties under treatment	11
Acreage	1,376
No. of bearing apple trees involved	73,850
Total yield in bushels	280,200
Bushels free from all codling moth injury	192,820
Bushels gain in clean fruit over 1925	57,690
Average percentage absolutely free from all codling moth injury	68.8
Percentage gain in freedom from injury in 1926	20.5
Maximum percentage freedom from injury	97.0
Minimum percentage freedom from injury	40.0
B. Excluding orchards Nos. 1A and 2 because of admittedly inadequate treatment	
No of orchard properties under treatment	11
Acreage	1,221
No. of bearing apple trees involved	66,150
Total yield in bushels	261,200
Bushels free from all codling moth injury	183,920
Bushels gain in clean fruit in 1926	57,940
Average percentage free from codling moth injury	70.4
Percentage gain in freedom from injury in 1926	22.1
Maximum percentage freedom from injury	97.0
Minimum percentage freedom from injury	50.0

COST OF THE OPERATION. As in many cases of this sort it has proven difficult to secure reliable cost figures but, as nearly as it could be determined, the total cost of the treatment operations, including scraping and banding, care of used containers, and spraying operations is about $70,000.00 or $50.80 an acre or $.27 a bushel. Of course the acre and bushel costs are average.

DISCUSSION. The comparative value of heavy spraying and care of used containers was rather well illustrated in a part of orchard No. 9. Standing on the edge of this orchard block was an open shed storehouse in which had been placed, during the preceding dormant season, about 40,000 used bushel hampers. It was impractical for the grower either to make this building moth tight or to treat or remove the baskets. It was, therefore, suggested to him that he keep the first ten rows adjacent to this storehouse heavily coated with spray materials during the period of entry by codling moth larvae of the first brood. This suggestion was pretty faithfully followed out. In spite of the fact that an enormous number of moths emerged from these used containers, as shown by the projecting pupal shells, at the close of the season fully

30% of the late fruit borne by trees immediately adjacent to the storage shed was absolutely free from all types of codling moth injury. The infestation of moths among the trees adjacent to this storage shed was extremely dense, yet very thorough spraying served to bring through fully 30%.

The study of the relation of scraping and banding to clean fruit, as set forth in Table No. 1, does not give definite results because a variation in the efficiency of the spray applications seems more than able to overcome the effect of scraping and banding. In orchard No. 3 the effect of incomplete use of these measures seems more prominent than in any other planting. This orchard was composed of large trees which yielded an average of a little better than twelve bushels each. In that section of this orchard where neither scraping nor banding was used, although the spraying given was apparently fully equal to that given in other parts of the orchard, the infestation was much heavier. In the carefully scraped and banded portion of this orchard the fruit free from all codling moth injury was easily 75%, while the sections not scraped and banded were wormy enough, when taken with a section in this same orchard later to be discussed, to pull down the average of the orchard to 60% fruit absolutely free from codling moth. In another section of orchard No. 3 there was a considerable number of early fruit trees which, because of the nature of the variety and the price obtaining for the same at picking time, were allowed largely to shed their fruit on the ground where it remained. In this section of the orchard the worm infestation was heavier than in any other part, although the spraying given it was fully equal to any other part. From these facts, the writer concludes that the failure to practice scraping and banding and to care for the early fruit, drops, and picks, resulted in a very greatly increased infestation, in spite of the character of the spraying done. Scraping and banding is, according to his point of view, an attempt to render the large rough-barked tree the practical equivalent, in point of a satisfactory place for the codling moth larvae to spin up, of the young smooth-barked tree. That scraping and banding in themselves, unaccompanied by satisfactory and complete spraying operations, are totally unable to control codling moth infestation is shown in the check orchard which was carefully scraped and banded but not satisfactorily sprayed, in which the late fruit showed an average of five worm holes per apple.

Movement of codling moth from untreated or unsuccessfully treated trees of bearing apple into the satisfactorily treated orchards results in an increase in infestation in that portion of the treated orchards

adjacent to this source of moths, as shown by the experience in orchard No. 11. The only worminess of any movement whatever in orchard No. 11 occurred at one end of the rectangular block of 276 acres standing adjacent to a small but old and uncared for orchard.

In an area very heavily infested with codling moth there seems to be two stages in the effort against it. The first is the stage of suppression or repression and requires far more intensive work than the one which follows. The second is the stage of codling moth control in which the infestation is not more than sufficient to infest 50% of the fruit on unsprayed trees in the orchard concerned. The difference is well illustrated by a comparison of orchard No. 11 with orchard No. 1. Orchard No. 11 in 1925, with a relatively limited amount of spraying, gave 60% fruit free from all codling moth injury. This orchard in 1926, with treatments designed to control the first brood only, gave 97% of the harvested fruit absolutely free from all codling moth injury. Orchard No. 11 represents the control phase of the codling moth problem. Orchard No. 1, which, under heavy spraying in 1925, gave 50% clean fruit, under very thorough spraying designed to control both broods in 1926 gave only 75% of the harvested fruit absolutely free from codling moth injury. Orchard No. 1 represents the suppression stage of the effort against codling moth.

It seems possible, where orchards are composed of trees easy to spray very thoroughly, and in which scraping and banding has been practiced, as needed, to obtain a remarkably large amount of the harvested fruit absolutely free from codling moth injury by the practice of very thorough spraying. Orchard No. 3B is an example of this condition. The owner and operator of orchard No. 3B told the writer that in 1925 he was sure that there was no fruit absolutely free from codling moth injury and that the whole crop was turned into cider; yet in 1926, in spite of the fact that a certain limited amount of scraping was necessary and was not done, very thorough treatment accompanied by thorough operation of the bands resulted in the harvesting of 85% of the fruit absolutely free from codling moth injury of all kinds. Judging from the 1926 experience in an organized effort against the codling moth in a district in which the moth is very abundant, the writer feels safe in saying that when the harvested fruit of the preceding year shows 90% absolutely free from codling moth injury of all kinds the codling moth suppressive effort has been completed and that control can be obtained by careful work designed to destroy the first brood only, except in cases

where this orchard is subject to heavy migrations from large adjacent plantings of uncared for bearing apple orchard.

The question of timing of the cover sprays for the destruction of codling moth in apple orchards where it is very abundant is somewhat different from the same question in which the codling moth infestation is comparatively light, say such as sufficient to produce not more than 50% worminess on unsprayed trees. In the first place determination of the time when the cover sprays should begin cannot be made in either type from the standpoint of tree development, as shown by the fact that this year the first cover spray for codling moth came at the time of our ordinary 17 day after blossom fall spray, instead of about 4 weeks after blossom fall, as is usually the case. The beginning of cover sprays for codling moth should, in the writer's experience, come when the moth appears in the orchard on the wing. Codling moth cages are inadequate for the purpose of determining this time because many different factors of difference between cage conditions and tree conditions enter in. It is possible that codling moth may begin to emerge in cages earlier than from the trees but, as a matter of fact, the reverse seems to be true. In view of this variation, it was felt that some other method must be used to determine the appearance of the moths in the orchard. For this purpose in 1926 the oriental peach moth bait pans were utilized. The pans were placed in the foliage wall of the tree, about half way between the top and bottom where, in previous years, the greatest number of fluttering moths had been observed. It seems that when the codling moth has emerged in the orchard, and the weather is such as to encourage it to lay eggs, pans placed in this position catch moths, thus telling the grower exactly when his enemy is abroad and when his danger time has arrived. A number of years experience has convinced the writer that the proper intensive spraying effort against the codling moth, under heavy infestation conditions, begins in time to have the cover on when the first worms start to enter and to keep it on during the entire period of entry. Spraying, therefore, should begin as soon as any considerable number of codling moths are caught in the bait pans and the film coating administered at that time should be kept by such replacement as may be necessary throughout the time that the moths continue to be caught in the bait pans. This year this effort involved three cover sprays for the first brood and two cover sprays for the second brood.

Further Plans. This effort represents the first of three years of work designed to reduce the codling moth to a point where 90% of

the picked fruit is entirely free. After this stage has been reached the insect can be controlled by the application of the regular schedule and intensive cover spraying for the first brood only.

MR. E. R. VAN LEEUWEN: I am very much interested in Dr. Headlee's report. I would like to ask if he thinks it is possible to conduct a clean-up campaign over a period of four or five years in such a way that the first brood can be controlled to the extent that there will be very little arsenic spraying done after the first few worms are found and probably solve this problem of arsenic remaining on fruit.

MR. T. J. HEADLEE: I would like to answer that question by saying "Yes if the man organizing the movement can keep the growers sold on the proposition." Orchard No. 11, 276 acres, with 60 per cent of the total picked fruit last year free from codling moth; this year treating for first brood only 97 per cent clean. There are now in this group two more orchards that are ready next year for first brood treatment only, and I believe they can handle the codling moth by that means in those two orchards. At any rate that will be the step taken in those two orchards. That will take three—the rest of the eight properties will come along on the same basis as this year.

MR. J. S. HOUSER: May I ask first if the emergence this year was normal; that is if the first brood was extended abnormally long. Secondly I would like to have your spraying schedule by which you accomplished that result.

MR. T. J. HEADLEE: The emergence brood spraying was perhaps a trifle longer than is normally the case. It certainly started considerably later than is normally the case. I will admit you to the secret that the second brood was chopped off a little earlier, all of which was in our favor.

The schedule is all outlined in the paper. It is our regular spraying schedule, with cutting such corners as the absence of certain insects and diseases permit us. The total cost of the whole operation, spray and orchard sanitation, was approximately $80,000. As you see, there are 73,850 trees in the entire project.

I rather hesitate to give the spraying schedule because of the time required.

MR. P. M. GILMER: I would like to ask Dr. Headlee if he thinks that adaptable where we have three full broods.

MR. T. J. HEADLEE: Of course it has been a long time since I worked in a three-brood area. I think our period of emergence of the moth in

the first brood was almost as long as the second or third. I don't know how to work the third-brood area. The only argument that a person can bring forward, of course, is that the first brood is apparently a parent to the second, and if you can kill the parent, you are not going to have many children.

FIRST VICE-PRESIDENT C. J. DRAKE. The next paper is by S. W. Frost.

FURTHER STUDIES OF BAITS FOR ORIENTAL FRUIT MOTH CONTROL[1]

By S. W. FROST

ABSTRACT

The relative attractiveness of various baits to the oriental fruit-moth, *Laspeyresia molesta*, is discussed. The results correlate very well with those made by the writer in 1925. The possibilities of weak acids, volatile oils or their ingredients, fermenting and non-fermenting baits are discussed. While fermenting baits give, on the whole, larger catches, the non-fermenting baits have a longer period of activity and may prove more practical for control purposes. The results clearly indicate that a more attractive bait must be had before adequate control can be expected. Orchard tests, where the infestation is not high, show a reduction of nearly 30% wormy fruit

During the season of 1926, the investigations of the previous summer were duplicated, enlarging the work considerably and increasing the number of test pails. Practically all the work was conducted in an orchard of Krummel peach trees near Arendtsville, Pa.

TESTS OF DIFFERENT TYPES OF BAITS

METHODS. The methods used during the current season simulated those of 1925 with the following changes (1) test pails were hung on every other tree in alternate rows, (2) at least five, and in some cases ten pails were used in testing different baits, (3) only number ten, tin pails, of approximately a gallon capacity, were used, (4) all pails, except a few used during the very first of the season, were painted, within and without, with white paint, (5) the pails were filled one-half full with bait and nothing was added during their operations except water to compensate for evaporation, (6) they were examined once a week, and the insects strained from them and taken to the laboratory for final examination, (7) all bait-tests were placed in the same block of krummel trees.

SEASONAL CONDITIONS. A few seasonal conditions should be taken into consideration in interpreting this paper. In general, the infestation

[1]Published by permission of the Director of the Agricultural Experiment Station as a part of Project No. 697. Contribution from the Department of Zoology and Entomology, The Pennsylvania State College, Technical Paper No. 416.

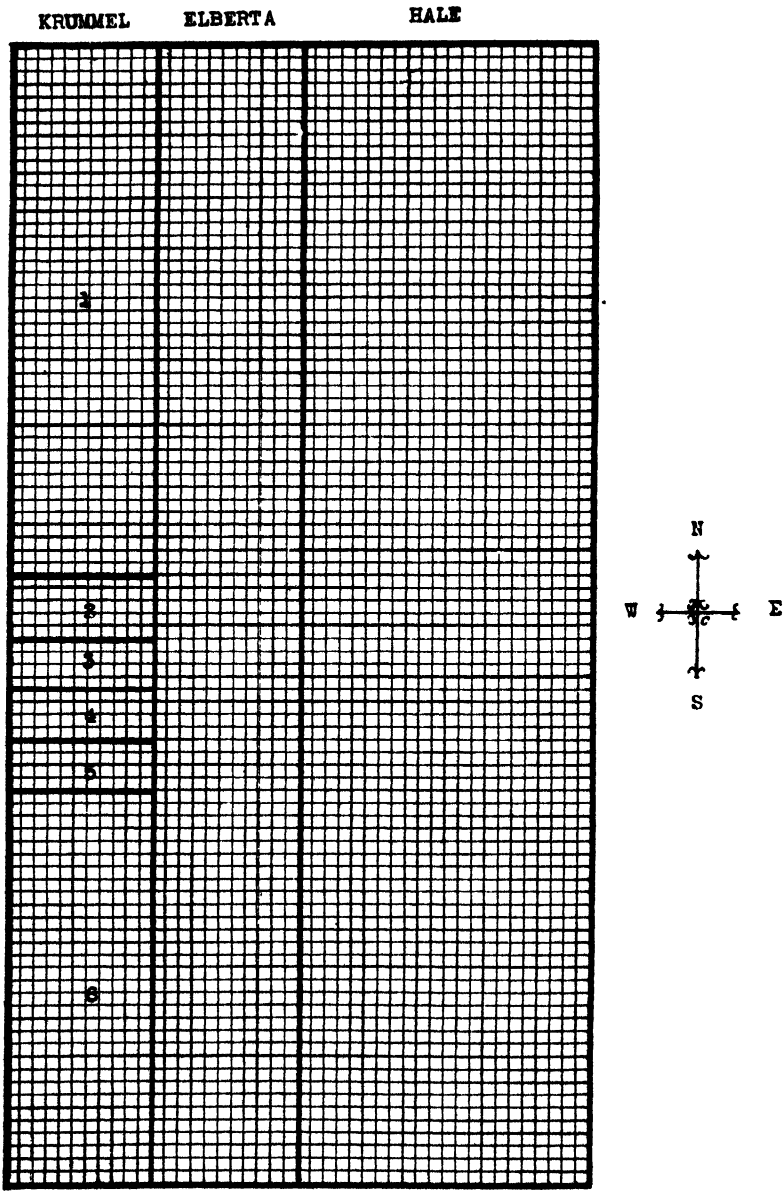
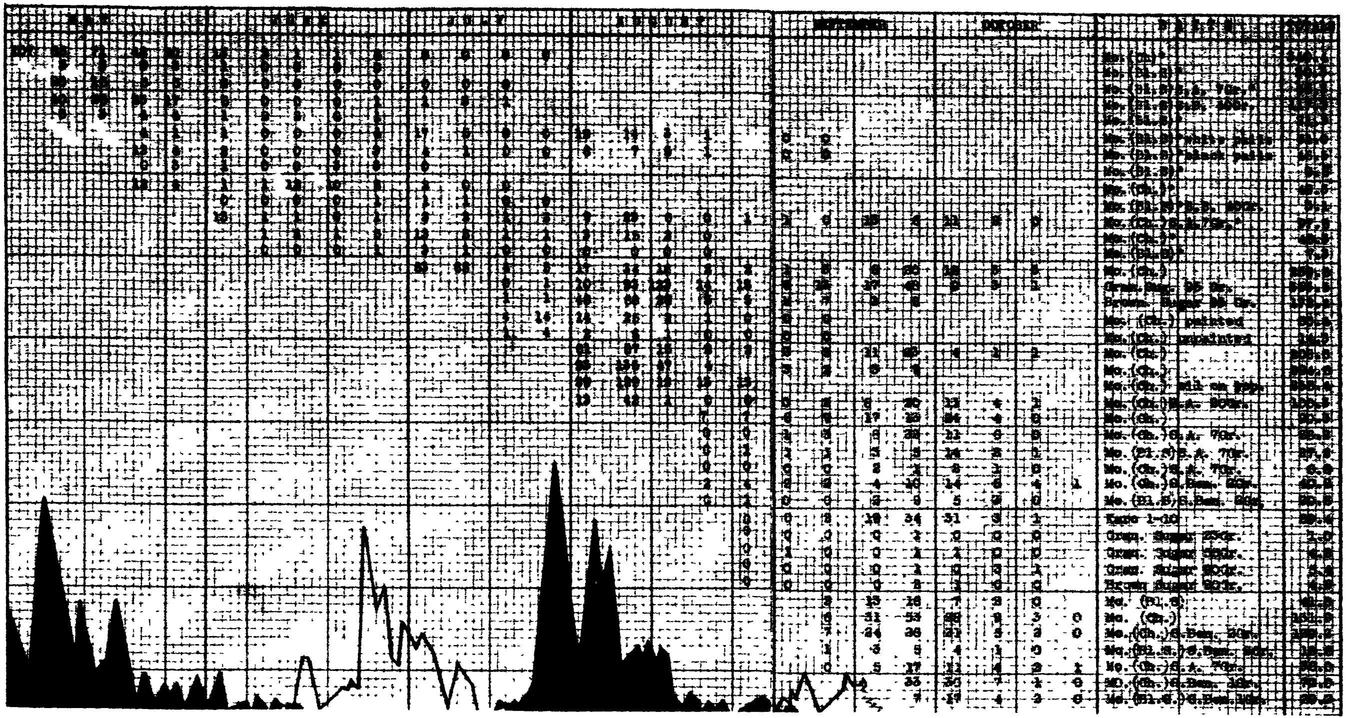


FIG. 8. A corner of the peach orchard showing location of pailed and unpailed blocks (each square represents a tree).



Weekly collections of oriental fruit moths from sugar baits. All reduced to number of moths per pail, see explanation).

was not high and apparently lighter than the preceding season. The moths were not observed flying in appreciable numbers at any time during the summer, and twig injury was scarcely noticeable in the orchard where tests were conducted.

Between May 5th and 11th, the catches in bait-pails were large, coinciding with the peak of emergence of the overwintering brood. The catches in bait-pails did not increase again in number until the middle of August corresponding with the peak of emergence of the second brood. It is believed that the high percentage of moths in the krummel block, in May, was due to the concentration of the larvae in this block the preceding Fall. (It should be noted that there are only 990 krummel trees to more than 11,000 trees of early varieties as Carmen Hale, Hiley, Elberta, etc.) A scattering of the moths then took place, going to the blocks of earlier fruit. After the removal of the early peaches, the percentage of moths increased again in the Krummel block.

In the second place the percentage of parasitism was remarkably low. During the second summer brood on July 5th to 15th, five hundred and fifty larvae were gathered from wormy peaches. Only two parasites emerged from these larvae. No record is available for the percentage of parasitism during the third brood but it was apparently light.

Weak Acids as Baits. The results of the work conducted by the writer in 1925,[2] clearly demonstrated that the acids formed in fermenting molasses and sugar solutions contributed largely to the attractiveness of such baits. It was hoped, therefore, that the fermenting bait could be replaced by a mixture of acid and water. Acetic acid, the principal acid involved, was tried but yielded nothing of merit. It was then thought that certain weak acids, occurring only in very small amounts as a result of fermentation, might be attractive to the oriental fruit moth. Consequently one or more tests were made, at various strengths, using Succinic, Salycilicic, Butyric and Benzoic acids. These, by the way, also occur in certain volatile oils which gave the writer additional reason for trying them. None, however, gave satisfactory results. Lactic acid

[2]Jl. Econ. Ent., 19:441–450, 1925.

EXPLANATION OF PLATE 2

Dilutions are given per pail.

10 pails were used in tests marked thus (*) otherwise 5 pails were used.

Tenths of moths are given only in the column of total to the right of the chart.

Mo. = Molasses, (Ch.) = Higrade molasses, (Bl. S.) = Low grade or Black strap molasses, S.A. = Sodium arsenite, S. B. = Sodium borate, S. Ben. = Sodium benzoate.

Emergence of moths represented by curves.

was tried because moths were seen frequenting water troughs where milk cans had been washed. The accompanying table of acid-baits shows plainly that such baits, at least at the dilutions used, are of no value. Higher dilutions would be too expensive and impractical.

RESULTS OF CERTAIN WEAK ACIDS USED WITH WATER AS BAITS FOR ORIENTAL FRUIT-MOTH

Bait[1]	Dilution[2]	Number of pails	Duration of test Period	No. days	Average[3] catch per pail
Acetic acid	12 c.c.	10	May & June	35 days	5.9
Acetic acid	10 c.c.	5	August	28 days	3.6
Acetic acid	5 c.c.	5	July	35 days	2.4
Acetic acid	5 c.c.	5	July & Aug.	35 days	1.4
Succinic acid	1 gr.	5	June & July	49 days	0.6
Salycilicic acid	2 c.c.	5	August	21 days	0.2
Butyric acid	1 c.c.	5	July & Aug.	49 days	0.4
Benzoic acid	2 c c.	5	August	35 days	0.6
Citric acid	1 gr.	5	July	35 days	2.6
Citric acid	1 gr.	5	July & Aug.	42 days	0.6
Lactic acid	1 c.c.	5	July & Aug.	49 days	2.2
Lactic acid	2 c.c.	5	July & Aug.	35 days	0.0

[1]In all cases the acids were diluted with ½ gal. of water and placed in No. 10, painted, tin pails.

[2]Dilution is figured on the amount placed in single pail

[3]The number of oriental fruit moths per pail.

VOLATILE OILS AS BAITS. Attention was then directed to certain volatile oils and some of their ingredients. Time permitted the trial of but a few of these. Two or three drops of linalool and geraniol were placed on the surface of water in two different series of pails but the catches approximated those from plain water. Such monatomic alcohols would not however be practical when used in this manner because they are too volatile and too expensive.

The property that the odors of certain volatile oils are readily absorbed by water, gave another suggestion for preparing an attractive bait. A deep, purple, strongly odoriferous volatile oil was extracted, by means of distillation, from peach leaves. The odorized waters, for convenience called "peach-leaf essence," was tried as baits on two occasions. Although no satisfactory results were obtained from these tests, the method still lends opportunity for further investigation with other volatile oils.

FERMENTING SUGAR BAITS. A series of tests was conducted to compare the relative values of fermenting sugar baits. Sugars were compared with molasses on the basis that granulated sugar is 99.8%,

brown sugar 82.% and molasses 40% cane sugar. The results, summarized in the accompanying charts, indicate that sugars and high grade molasses are more attractive than low grade molasses, and that certain non-fermenting baits were nearly as attractive as the fermenting baits. Karo likewise gave large catches of moths.

SOME MISCELLANEOUS BAITS. A few miscellaneous materials were tried as baits and are summarized in the accompanying table. Karo suggested glucose but the results were disappointing. It is interesting to note that red engine oil increased the catch when placed on the surface of water. This was used in a few tests to reduce slopping and prevent excessive evaporation.

RESULTS OF SOME MISCELLANEOUS BAIT-TESTS CONDUCTED DURING 1926

Bait	Dilution[1]	Number pails	Duration of test Period	No. days	Average catch per pail
Water		5	May to July	96 days	1.5
Water		5	July & Aug.	49 days	3.0
Water, red engine oil on top		5	Aug.	42 days	14.2
Ethel alcohol & water	4 c.c.	5	June	35 days	0.2
Glycerine & water	2 c.c.	5	July	35 days	0.4
Glucose & water	10 c.c.	5	July & Aug.	35 days	0.6
Flour & water	1½ oz.	5	Aug. & Sept.	49 days	10.8
Saccharine & water	½ gr.	5	June	35 days	0.4
"Peach leaf-essence"		5	Aug.	21 days	2.6
"Peach leaf-essence"		5	Sept. & Oct.	56 days	0.6

[1]The dilution is figured on the amount placed in each pail.

NON-FERMENTING BAITS. Various antiseptics or preventatives, chiefly sodium salts, were added to sugar and molasses baits to inhibit the development of yeasts, bacteria and molds, and thus to prolong the active period of the bait. This results in a sweet bait, of uniform character, operating without change over a long period of time. One bait of this type was still sweet and actively functioning at the end of 147 days.

Sodium arsenite is objectionable because it strongly favors the growth of mold, is expensive and causes serious burning to foliage and bark whenever it is spilled. On the other hand Sodium benzoate inhibits mold growth, also prevents fermentation, is inexpensive and otherwise as effective. During 1925 the catches from Sodium arsenite baits surpassed those from plain molasses baits, but during the present season the catches from molasses baits was slightly higher. From a practical standpoint, however, the non-fermenting baits may prove more satisfactory.

The following table summarizes various tests with different antiseptics to inhibit the growth of yeasts, bacteria and molds. Fermentation was determined by means of fermentation tubes and mold growth simply by an examination of the surface of the bait. Sodium benzoate at the rate of 2 ounces to ½ gal. of bait is a satisfactory antiseptic for this purpose.

A STUDY OF SOME ANTISEPTICS INHIBITING THE GROWTH OF YEASTS, BACTERIA AND MOLDS[1]

Antiseptic	Fermentation occurring at end of	No fermentation at end of	Amount of fermentation	Mold on top of bait
Sodium hypochlorite 14 grams*	26 days		Strong	Abundant green
Sodium chloride 113.4 grams	2 days		Strong	?
Sodium chloride 113.4 grams	2 days		Strong	Abundant
Sodium carbonate 14 grams	1 day		Strong	Abundant
Sodium carbonate 50 grams*	4 days		Strong	Abundant
Sodium bicarbonate 14 grams	1 day		Strong	Abundant
Sodium bicarbonate 50 grams*	3 days		Strong	Abundant
Sodium borate 20 grams*	16 days		Moderat	Abundant
Sodium borate 20 grams	18 days		Strong	Abundant white
Sodium borate 50 grams*		50 days	Moderate	Abundant white
Sodium borate 113.4 grams		50 days	Moderate	None
Sodium arsenate 10 grams	4 days		Slight	Abundant green
Sodium arsenite 7 grams	20 days			Some
Sodium arsenite 7 grams*	13 days		Slight	Some
Sodium arsenite 14 grams*	28 days		Slight	Abundant
Sodium arsenite 14 grams		50 days		Abundant
Sodium arsenite 20 grams*		120 days[2]		Abundant black
Sodium benzoate .25 grams*	2 days			Some
Sodium benzoate .5 grams*	2 days			Some
Sodium benzoate 1 gram*	5 days		Trace	None
Sodium benzoate 1 gram*	6 days		Trace	None
Sodium benzoate 8 grams*		60 days		None
Sodium benzoate 1 gram*	29 days		Trace	None
Sodium benzoate 2 grams*		60 days		None

[1]All the baits consisted of 200 c.c. high grade molasses to 2000 c.c. water. Samples marked thus (*) were placed in an incubator at 30°C. The others were run at room temperatures from June to September,

[2]Dr. D. E. Haley, Agricultural Chemist, Penna. State College, carried on some experiments and found that .25 gram of sodium arsenite did not interfere with the fermentation process, .5 and .75 grams delayed it while 1 gram completely inhibited the reaction, when added to 10 grams of high grade molasses.

Orchard Tests of the Bait-Pail Method of Control

A block of 990 krummel peach trees was selected for different tests. Plot No. 1, containing 451 trees, was used from May 1st to November 1st to compare various types of baits.

Plot No. 2, consisting of 55 trees was left as a barrier between plots Nos. 1 and 3.

In plot No. 3 bait pails were hung on June 8th on each of 44 trees, filling them one-half full with a mixture of 1 part high grade molasses and ten parts water. Water was added to these pails on June 29th, July 20th and August 3rd. On August 10th new bait composed of granulated sugar and water was added.

Plot No. 4, consisting of 44 trees, was left unpailed, as a check.

Plot No. 5, containing 44 trees was equipped with pails on August 1st, placing a pail on each tree and filling them with a mixture of 1 part high grade molasses and ten parts water. Water was added on August 27th. On September 10th they were replenished by new bait consisting of granulated sugar and water.

Plot No. 6, comprising 352 trees was left unpailed, with the exception of a few pails (about 40) placed there by the orchardist. These were of little account from the control standpoint.

The diagram of the orchard shows the relative position of the pailed and unpailed trees. Only a corner of the orchard is shown. To the south of this portion there are over 8,000 trees of the varieties; Carmen, Elberta, Smock and Fox seedling.

Results. An attempt was made to gather and examine 100 picked peaches from the plots every two weeks. The accompanying figure are not very complete but clearly show the steady increase of infestation with the progress of the season.

Examination of Krummel Peaches from Pailed and Unpailed Plots During the Summer[1]

Date of examination	Percentage of wormy fruit in		
	Plot 3 Pailed June 8	Plot 4 Unpailed	Plot 5 Pailed August 1
June 24	0	—	—
June 30	0	—	—
July 13	1	—	-
August 3	1	1	—
August 17	7	5	4
August 31	6	5	—
September 14	2	7	6.5
September 14[2]	4	10	5

[1]All examinations except the last were based on 100 picked fruit.

[2]Based on 1000 fruit in each plot, gathered in thinning.

Tallies of picked fruit were made on October 12th and 13th. At this time practically all the fruit had been removed from the orchard, except fruit on trees tagged for counts. The fruit was picked somewhat earlier than usual. The percentage of wormy fruit was not high and the percentage of infestation only slightly higher than the percentage of wormy fruit in the unpailed plots.

SUMMARY OF ORIENTAL FRUIT MOTH COUNTS IN RICE, KRUMMEL PEACH BLOCK, ADAMS CO., PA., 1926

Plot	No. fruit examined	No. wormy fruit	No. of worms	Percentage wormy fruit	Percentage infestation
3, Pailed June 8	1424	257	257	18.0	18.0
4, Unpailed	1970	429	444	21.7	22.5
5, Pailed Aug. 1	1512	298	306	19.6	19.9
6, Unpailed	1437	646	757	44 9	52.6

On the basis of the preceding studies as well as the investigations of the previous season, the writer believes that bait-pails still deserve merit as a control measure for the Oriental fruit moth. Large numbers of certain insects as, *Euphoria fulgida*, two species of *Cotinis*, *Carpocapsa pomonella*, and other injurious insects have been captured in bait-pails and this method may prove of value in controlling other pests.

FIRST VICE-PRESIDENT C. J. DRAKE: The next is a paper by Alvah Peterson.

SOME BAITS MORE ATTRACTIVE TO THE ORIENTAL PEACH MOTH THAN BLACK-STRAP MOLASSES

By ALVAH PETERSON, *Entomologist, Deciduous Fruit Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

A number of the bait experiments of previous seasons for *Laspeyresia molesta* were repeated and in most cases the results obtained were duplicated. Enameled stewpans and wide mouth, glass, quart jars proved to be the most satisfactory containers.

Some 250 aromatic chemicals were tested. Terpineol and several essential oils (fennel, Bergamot, star anise, anise seed and *Pinus sylvestris*) were somewhat attractive to moths. If one compares the attractiveness of any one of these products with that of several fermenting sugar-possessing products it is much less.

Fermenting fruits (dried fruit in water), particularly prunes, pears and apricots, attract a goodly number of moths.

Baits made of cheap black-strap molasses (5 to 20 per cent dilutions) are fairly attractive but they usually produce considerable scum and their period of attractiveness is not very long.

Honey, corn syrups, refiner's syrups and brown sugar (5 or 10 per cent solutions) are much more attractive than black-strap molasses. These products and others of

a similar nature produce little or no scum when fermentation occurs and their period of attractiveness is of considerable length (several weeks).

Fermentation or some change occurs in all baits made of sugar-possessing commercial products before they become very attractive to the oriental peach moth. Several of the common disinfectants delay but do not permanently prohibit fermentation when added to the sugar-possessing products used in the experiments.

Further investigational work on baits attractive to the oriental peach moth, *Laspeyresia molesta* Busck, was conducted by the author in orchards about Riverton, New Jersey during the growing season of 1926. A number of interesting facts were learned and a few of the more important ones will be discussed.

METHODS. In all of the tests, unless stated otherwise, two quart enameled stewpans were used (for description see reference 2). During mid-season over one thousand bait containers were located in nearby orchards and examined daily or three times per week. The location of the containers in the orchards in all of the experiments was made as nearly the same as possible, e. g. they were placed at the same height, usually on the same side of the trees, among trees of the same variety and equally distributed, as a rule one in every other tree in every other row. Each product was tested in units of five or ten containers. In a few tests forty or more containers were employed for each product.

The tables show the total catch of moths for the period covered by each test. Some of the more important experiments are included in the tables. Space will not permit a presentation of the number of moths caught in individual pans or the totals for each collection. This eliminates the possibility of demonstrating the influence of weather conditions on the catch. It will also be necessary to omit information which would illustrate the period of time that each bait is most attractive.

For two seasons at Riverton, New Jersey the most favorable time to make observations on the attractiveness of baits has been during the period when the first brood adults are present in the orchard, usually late in June or early in July.

GENERAL. Some of the experiments conducted during previous seasons were repeated in order to obtain further proof on former observations. It was noted again that bait containers kept well filled with baits (Table 1) catch many more adults than when partly filled. The most satisfactory container from the standpoint of the number of moths caught again proved to be an enameled stewpan, two quarts capacity (Tables 1 and 2). The next best container was a wide-mouth, quart, glass jar. In some of the tests where the jars were placed high in the

trees they caught nearly as many adults as the stewpans. Further tests this year showed that containers (jars used) located high in the trees catch more moths than when placed low (Table 1).

Tin and aluminum containers are not very durable when filled with fermenting baits. There appears to be a chemical reaction between the bait and the metal. This is particularly true with aluminum ware. Tin or rusty containers have some influence on the attractiveness of a fermenting bait. In several tests a marked reduction in the catch occurred when the bait was suspended in rusty or tin containers.

Aromatic Chemicals. A considerable number (about 250) of aromatic chemicals were tested during May and June in several apple and peach orchards to determine their attractiveness to oriental peach moths. These products were largely essential oils, alcohols, esters, aldehydes, acids and sugars. The various chemicals were placed in small evaporating cups (for description see reference 3) and floated on water in two quart enameled stewpans. The following products were sufficiently attractive to bring moths to the pans so that one or more specimens were taken in each of five or more collections; terpineol, fennel oil, Bergamot oil, star anise oil, anise seed oil and *Pinus sylvestris* oil. Moths were taken at three different collections from pans possessing isosafrol and terpinyl acetate. The following products, had one or two moths in one or two collections; essential oils such as citronella, petit grain, thyme (white and red), peach kernels, neroli, capsicum, hemlock, savin, turpentine, rose geranium, lemon, clove, sage, cymene, eucalyptus pennyroyal and lavender fleurs; also anthranilic, acetic and uric acids, benzyl, hexyl and iso-propyl alcohols, glycerine, aldehyde, cresol, m-cresol, cinnamaldehyde, salicyaldehyde, beta-bromostyrene, pyridine, furfural, benzyaldehyde, toluol, menthol, betaine hydrochloride, hyoscyamine, leucine, gum arabic, frangula bark, iso-butyl n-butyrate, amyl salicylate, limonene, iso-amyl valerianate, iso-butyl phenylacetate etc. The author is of the opinion that many of the products just named are not attractive. The presence of moths in pans possessing the chemicals was probably accidental in many cases. No one aromatic chemical or commercial product proved to be anywhere near as attractive as many of the fermenting molasses, syrup, sugar and fruit baits.

Dried Fruit. Several dried fruits, peaches, pears, prunes, apricots and apples, were used to attract moths. In most of the tests similar amounts of each fruit (usually 30 to 35 grams) were placed in enameled stewpans filled with clean water. No adults came to the pans until the fruit started to ferment. During the summer it usually took three to

seven days for fermentation to get a good start. As soon as bubbles, due to fermentation, appeared, moths came to the pans. The maximum catch of moths usually occurred seven to fourteen days after the fruit was placed in the orchard. The few tests made with dried fruit (Table 6a) show that prunes and pears are probably the most attractive, apricots and peaches come next and apples last. Dried fruit when placed in water absorbs moisture and as soon as fermentation starts the fruit usually becomes lighter than water and floats on the surface. Floating fruit undoubtedly interferes with the maximum catch. It is probable that submerged, fermenting, fruit will catch more adults.

If one compares the attractiveness of fermenting dried fruit baits with that of baits made up of fermenting molasses, syrup or sugars the former is usually less attractive. Some of the individual collections from fruit baits ran higher than molasses, syrup and sugar baits but their period of attractiveness was much shorter, consequently the total catch was smaller.

Mr. E. H. Siegler and Mr. L. Brown conducted some bait experiments with dried fruits, sugars and syrups in Maryland peach orchards this past season. They kindly furnished me a copy of their field notes. Their experiments indicate that apricots were the most attractive of the dried fruits. The results they obtained with other products agree closely with those reported upon in this paper.

Syrups etc. In the June issue of this Journal for 1926 the author (reference 2) reported that a five or ten per cent solution of stock molasses, (black-strap molasses) was attractive to oriental peach moths. Two seasons experience with this product show that there are several difficulties to be overcome if black-strap molasses is to be used as a control measure. The chief objection is the fact that ten and twenty per cent solutions ferment rapidly and form an excessive amount of foam which results in a thick or thin scum over the surface of the liquid. This interferes with the capture of adults which come to the containers. The scum has to be removed two or three times after fermentation starts if a number of adults are to be caught. Five per cent solutions do not produce a great amount of scum as a rule but in hot weather this strength produces more than desired. If bait pans are only examined every week or two, scum formation would materially reduce the number of moths captured. Another objection to the use of black-strap molasses for baits is the fact that its period of maximum attractiveness to moths is relatively short.

During the past season baits made of cheap black-strap molasses have been compared with baits made of several common, sweet, com-

mercial products (syrups and sugars) particularly those possessing a sugar content higher than black-strap molasses. The tables (4, 5 and 6) show that there are several products which are superior to black-strap molasses in that they attract more moths, they produce little or no scum and their period of maximum efficiency is much longer. These products are honey, dark and light colored corn syrups, refiner's syrups and brown sugars. Coarse corn sugar, some grades of table molasses and hydrol proved to be as attractive as black-strap molasses in some of the tests.

Honey is probably the most attractive product found to date (Tables 4 and 5). The chief objection to honey is the fact that honey bees may consume all of the bait if there is a shortage of food in the vicinity where the baits are located. The cost of honey also prohibits its use.

Corn syrup (Tables 2, 4, 5 and 6), particularly one of the common dark colored grades on the market, has proven to be very attractive. As a rule it takes longer for a ten per cent (or greater strength) solution of corn syrup to become attractive than most other baits of a similar nature but once the attractive stage is reached the period of attractiveness is usually much longer than that of any other bait. Corn syrup baits seldom if ever form a scum on their surface. They are considerably more expensive than black-strap molasses but cheaper than honey.

Several grades of refiner's syrups (Tables 2, 4 and 6) proved to be very attractive, particularly five and ten per cent solutions. In most tests the five per cent solution was the best. Baits made of refiner's syrups become attractive a few hours, twenty-four to forty-eight, after they are placed in the orchard. Refiner's syrups cost 25 to 40 cents per gallon in fifty gallon lots. This is two or three times the cost of black-strap molasses.

Brown sugars (Tables 4, 5 and 6) in some of the tests proved to be decidedly attractive to moths, particularly ten and twenty per cent solutions. There was some variation in the results obtained however, with the several grades tried which could not be accounted for. Coarse and fine corn sugars (Tables 4 and 5) also caught large numbers of adults in some of the tests. Coarse corn sugar is cheap and may prove to be quite satisfactory. The sugar baits formed no scum on the surface of the liquid. One or two grades of table molasses and hydrol also proved to be fairly satisfactory and more attractive than black-strap molasses in some instances.

Space will not permit a presentation of the chemical analyses of the several commercial products employed. Comparing the chemical make-up of the several products with the respective attractiveness of

each it appears that those products which have a sugar content greater than 62 per cent caught many more adults than similar products, such as black-strap molasses, where the sugar content was 48 to 54 per cent. Further tests are needed to corroborate this conclusion.

FERMENTATION. The results obtained this season convince the author more firmly than ever before that any sweet product (molasses, syrup or sugar) must start to ferment or undergo some sort of a change before it becomes very attractive to oriental peach moths. Honey appears to be the only product which will attract a goodly number of moths the first days it is placed in the orchard. Even baits made of honey become more attractive when they have been outdoors a few days and show distinct signs of fermentation or some change.

Yeast is unnecessary to start fermentation. Early in the spring when the nights are cold the addition of yeast will hasten fermentation. A natural infection of fermenting organisms always occurs under orchard conditions; however, in cool weather, it always takes longer to start than in hot weather.

In a number of tests some of the more common disinfectants were used to prevent fermentation (Table 3). As long as no fermentation took place few or no moths came to the baits. To our surprise most of the common disinfectants employed were effective for a few days only. All delayed fermentation, but sodium benzoate, 1–100, was the only product which usually prevented fermentation and when this was used very few moths were found in the containers during the entire period of each test. Several strengths of the disinfectants were tried. The following were the maximum strengths tested; bichloride of mercury, 1–1000, sodium arsenite 1–500, potassium permanganate, 1–200, copper sulfate, 1-500, chlorinated lime, 1-1000, and sodium benzoate, 1-100. In another series of tests the fermenting baits were taken into the laboratory and boiled for one hour and then returned to the orchard. Boiled baits for a few days after they were replaced in the orchard always caught a smaller number of moths than baits which had not been boiled. The total catch of moths taken from molasses and syrup baits where disinfectants were added was usually much smaller than from containers which held untreated baits.

CONTROL. A conclusion on liquid baits as a possible means of control will not be made at this time. Present indications point to the fact that a liquid bait may prove to be impractical and ineffective. The author advises growers to refrain from using baits as a means of control until more definite information can be given.

References

1.—1925. Alvah Peterson. A bait which attracts the oriental peach moth (*Laspeyresia molesta* Busck). Jour. Econ. Ent., vol. 18, pages 181–189.

2.—1926. Alvah Peterson. Additional information on baits attractive to the oriental peach moth, *Laspeyresia molesta* Busck. Jour. Econ. Ent., vol. 19, pages 429–439.

3.—1926. Alvah Peterson. An evaporation cup useful for chemotropic studies of insects in the field. Jour. Econ. Ent., vol. 19, pages 863–866.

4.—1926. S. W. Frost. Bait-pails as a possible control for the oriental fruit moth. Jour. Econ. Ent., vol. 19, pages 441–450.

Table 1. Bait Containers, Their Location, Etc.

Results of several miscellaneous bait experiments extending from May 1 to September 8, 1926 in Taylor's peach orchard near Riverton, New Jersey. All of the containers were filled with the following baits, table molasses, 1–15 plus yeast from May 1 to May 17, black-strap molasses, 1–10 plus yeast from May 19 to June 30, and dark corn syrup from June 31 to September 8. In experiments 1a to 4a the four types of containers were located at the same height in each (same) tree. In experiments 5b to 7b the three jars at different heights were located in each (same) tree. In experiments 8c and 9c the two tin pails, one filled and the other one-third filled were located in each (same) tree. In experiments 10d and 11d one pan and one jar were located in each (same) tree at heights indicated.

Number and series	Container	Feet above ground	Number of containers	Number of trees	Number of moths	Series %
1a	Two quart enameled stewpan	5	5	5	1318	60.4
2a	One quart wide-mouth glass jar	5	5	5	296	13.1
3a	Three quart tin pail	5	5	5	317	14.0
4a	One quart tin pail	5	5	5	248	11.3
5b	One quart wide-mouth glass jar	2–3	5	5	117	14.4
6b	One quart wide-mouth glass jar	5–6	5	5	262	32.2
7b	One quart wide-mouth glass jar	7–9	5	5	433	53.3
8c	Three quart tin pail, filled	5	10	10	421	83.3
9c	Three quart tin pail, one-third filled	5	10	10	84	16.6
10d	Two quart enameled stewpan	5	10	10	1500	63.6
11d	One quart wide-mouth glass jar	7–9	10	10	856	36.3

Note. A given series of tests is designated by a common alphabetical letter.

Table 2. Bait Containers and Their Location

Moths caught in bait experiments conducted at Wetherby's peach orchard near Swedesboro, New Jersey. There were five containers in each test and they were examined once a week. In all of the experiments the stewpans were placed 5–6 feet above ground, the tin pails 7–8 feet above ground and the quart jars 9–12 feet above ground. In experiments 2a, 4b, and 7c there were three containers in each tree, one of each type but in all other tests only one container was placed in each tree.

Number and series	Material	Containers per tree	Period of test	Two quart stewpans	Three quart tin pails	One quart wide-mouth glass jars
1a	Black-strap molasses, 10%	1	May 30 to June 21	217	162	150
2a	Black-strap molasses, 10%	3	May 30 to June 21	92	79	72
3b	Black-strap molasses, 10%	1	June 21 to July 26	51	14	56
4b	Dark corn syrup, 10%	3	June 21 to July 26	234	48	97
5b	Dark corn syrup, 10%	1	June 21 to July 26	203	30	80
6c	Black-strap molasses, 10%	1	July 26 to Sept. 20	53	27	45
7c	Refiner's syrup, 5%	3	July 26 to Sept. 20	488	68	289
8c	Refiner's syrup, 5%	1	July 26 to Sept. 20	465	111	497
	Totals			1803	539	1286
	Percentage of grand total			49.7	14.8	35.4

Note. A given series of tests is designated by a common alphabetical letter.

TABLE 3. MOTHS CAUGHT IN BAITS CONTAINING SOME OF THE COMMON DISINFECTANTS

These tests were conducted in peach orchards near Riverton, New Jersey. There were five containers in each test. Experiments 1 and 2 started August 14 and ended October 1, experiment 3 started August 3 and ended September 4 and experiment 4 started August 31 and ended October 1.

Number	Material 10%	Check	Sodium benzoate, 1–100	Potassium permanganate, 1–200	Mercuric chloride, 1–1000	Sodium arsenite, 1–500	Chlorinated lime, 1–1000	Copper sulfate, 1–500
1	Table molasses	236	0	102	53	113	—	—
2	Refiner's syrup	165	5	145	200	43	—	—
3	Refiner's syrup	324	6	289	171	—	—	—
4	Table molasses	59	41*	24	41	70	124	35

*Sodium benzoate, 1–300.

TABLE 4. MOTHS CAUGHT IN SOME OF THE BAIT EXPERIMENTS CONDUCTED IN TAYLOR'S PEACH ORCHARD. TEN CONTAINERS USED IN EACH TEST. FIVE AND TEN PERCENT SOLUTIONS.

Number	Material	Period of test	Moths caught 5%	Moths caught 10%
1a	Black-strap molasses	July 2 to August 16	105	115
2a	Table molasses	July 2 to August 16	676	352
3a	Corn syrup, dark	July 2 to August 16	783	1386
4a	Refiner's syrup, medium	July 2 to August 16	1255	1028
5a	Sugar syrup, syrline	July 2 to August 16	135	369
6a	Honey	July 2 to August 16	1592	1822
7a	Cane sugar	July 2 to August 16	299	182
8b	Refiner's syrup, 208	July 17 to August 13	25	391
9b	Refiner's syrup, 226	July 17 to August 13	106	166
10b	Corn syrup, dark	July 17 to August 13	24	192
11b	Corn syrup, unmixed	July 17 to August 13	50	41
12b	Hydrol	July 17 to August 13	189	204
13b	Honey*	July 17 to August 13	31	38
14c	Honey	July 8 to August 9	482	——
15c	Refiner's syrup, medium	July 8 to August 9	306	——
16c	Table molasses	July 8 to August 9	276	——
17c	Brown sugar, N. O.	July 8 to August 9	224	——
18c	Corn syrup, dark	July 8 to August 9	174	——
19c	Corn sugar, fine	July 8 to August 9	171	——
20c	Corn syrup, light	July 8 to August 9	118	——
21c	Dextrine, white	July 8 toAugust 9	99	——
22c	Corn sugar, coarse	July 8 to August 9	93	——
23c	Black-strap molasses	July 8 to August 9	88	——
24c	Dextrine, yellow	July 8 to August 9	30	——
25c	Corn starch	July 8 to August 9	15	——
26c	Soluble starch	July 8 to August 9	0	——
27c	Water, check	July 8 to August 9	3	——
28d	Black-strap molasses	June 24 to August 20	444	——
29d	Corn syrup, dark	June 24 to August 20	978	——

*Honey bees consumed bait.

Note. A given series of tests is designated by a common alphabetical letter.

TABLE 5. MOTHS CAUGHT IN SOME OF THE BAIT EXPERIMENTS CONDUCTED AT LIPPINCOTT'S PEACH ORCHARD, RIVERTON, N. J.

Number and series	Material	Period of test	Number of pans	Total moths in ten pans (average)
1a	Black-strap molasses, 10%	June 29 to July 12	69	55
2a	Corn syrup, dark, 10%	June 29 to July 12	41	585
3b	Black-strap molasses, 10%	June 22 to August 2	10	195
4b	Black-strap molasses, 10% plus saponin, 1-5000	June 22 to August 2	12	151
5b	Black-strap molasses, 5%	June 22 to August 2	10	263

6b	Black-strap molasses, 10% plus sodium arsenite, 5 gm. per pan	June 22 to August 2	8	206
7b	Table molasses, 5%	June 22 to August 2	9	454
8b	Corn syrup, dark, 5%	June 22 to August 2	9	1423
9b	Corn syrup, light, 5%	June 22 to August 2	11	1169
10b	Honey, 5%	June 22 to August 2	10	861
11c	Brown sugar, N. O. 10%	August 3 to September 4	9	263
12c	Brown sugar, soft cane, 10%	August 3 to September 4	9	248
13c	Brown sugar, F, 10%	August 3 to September 4	10	174
14c	Corn sugar, fine, 10%	August 3 to September 4	10	171
15c	Corn sugar, coarse, 10%	August 3 to September 4	11	386
16c	Hydrol	August 3 to September 4	10	340
17c	Corn syrup, unmixed, 10%	August 3 to September 4	11	194
18c	Corn syrup, dark, 10%	August 3 to September 4	12	159
19c	Corn syrup, light, 10%	August 3 to September 4	11	190
20a-c	Water, check	June 22 to September 4	10	5

Note. A given series of tests is designated by a common alphabetical letter.

TABLE 6. MOTHS CAUGHT IN BAIT EXPERIMENTS CONDUCTED AT RICHIE'S PEACH ORCHARD NEAR RIVERTON, NEW JERSEY. FIVE CONTAINERS USED IN EACH TEST. TWO AND FIVE TENTHS, FIVE AND TEN PER CENT SOLUTIONS.

Number and series	Material	Period of test	Moths caught 2.5%	5%	10%
1a	Black strap molasses	June 26 to July 22	317	212	143
2a	Corn syrup, dark	June 26 to July 22	168	434	840
3a	Refiner's syrup, medium	June 26 to July 22	122	1290	785
4b	Black-strap molasses	July 31 to September 1	47	80	117
5b	Corn syrup, dark	July 31 to September 1	42	29	157
6b	Refiner's syrup, 208	July 31 to September 1	52	84	134
7b	Refiner's syrup, 226	July 31 to September 1	69	218	178
8b	Brown sugar, F.	July 31 to September 1	30	81	267
9c	Cane sugar	July 3 to July 22	—	101	—
10c	Brown sugar, F.	July 3 to July 22	—	818	—
11c	Corn syrup, dark	July 3 to July 22	—	197	—

TABLE 6a. MOTHS CAUGHT IN SOME OF THE DRIED FRUIT BAIT EXPERIMENTS (RICHIE'S ORCHARD) NEAR RIVERTON, NEW JERSEY. FIVE CONTAINERS USED IN EACH TEST.

Number and series	Fruit, per pan	Period of test	Moths
12a	Prunes, four	June 26 to July 22	422
13a	Apricots, six halves	June 26 to July 22	155
14a	Peaches, three halves	June 26 to July 22	121
15a	Pears, two halves	June 26 to July 22	474
16d	Prunes, 30–35 grams	July 31 to September 1	17
17d	Apricots, 30–35 grams	July 31 to September 1	53
18d	Peaches, 30–35 grams	July 31 to September 1	158
19d	Pears, 30–35 grams	July 31 to September 1	68
20a, d	Water, check	June 30 to September 1	2

Note: A given series of tests is designated by a common alphabetical letter.

Mr. N. E. McIndoo: I would like to ask Mr. Peterson if he is keeping a record of the number of male and female moths and a record of other insects.

Mr. Alvah Peterson: Yes, we are keeping records of male and female moths. In certain catches we determine the number of insects and the condition of the females. So far the average will run about fifty per cent females and fifty per cent males and most of the females caught have not deposited their eggs.

To a limited extent we are taking care of other insects. We get so many other insects that we can't handle all of them. We have some very interesting facts along that line. Two or three important species of wireworms came to the pans in large numbers, and one or two other species. Of course we kept track of the codling moths that came to these pans.

Mr. G. A. Dean: It may be of interest to know that in our efforts to find some attrahent that might be effective in a bait for wireworms, we found common honey is the outstanding attrahent for the beetles, and with us the price of honey is not prohibitive, due to the fact that we can get a cheap alfalfa honey from California for seven cents, and it has a very strong odor. I would like to know if they have found that honeys with strong odors are more attractive than the mild honeys.

I will also say that in all our grasshopper and cutworm and army worm baits, the baits are far more attractive when the juices have been fermented, or even the black-strap molasses, where the juices have had an opportunity to ferment over night.

Mr. Phillip Garman: What price have you been paying?

Mr. Alvah Peterson: It runs between twenty-two and thirty cents a gallon for refiners' syrup in fifty-gallon lots.

Secretary C. W. Collins: I would like to ask if you have tried preserving the females in gasoline, xylol, benzol or something of the kind, or the tips containing the reproductive organs to attract the males.

Mr. Alvah Peterson: No, we have not.

Secretary C. W. Collins: We conducted some experiments with the gipsy moth along those lines and have had encouraging results and also some that were not so encouraging, because it is so variable. With some experiments of that kind this year in New Jersey we had some cages with tips preserved in xylol and we attracted some males in a few places where scouting had been done pretty thoroughly, and probably in that area we would not have been able to have repeated this work within a year or so, and this gave us a clue to go back to this area. A very bad

infestation has just turned up in that area as a result of these attraction experiments, using the tips in xylol.

FIRST VICE-PRESIDENT C. J. DRAKE: The next paper is by L. A. Stearns.

THE HIBERNATION QUARTERS OF *LASPEYRESIA MOLESTA* BUSCK[1]

By LOUIS A. STEARNS, *Assistant Entomologist, Agricultural Experiment Station, New Brunswick, New Jersey.*

ABSTRACT

In 1924, experimental orchard cultivation, supported later by laboratory tests, showed conclusively that thorough cultivation, during the latter part of the month of April, consisting of a plowing to the depth of six inches followed by a disking to the depth of four inches was 100 per cent efficient in the destruction of the larvae and pupae of the Oriental Peach Moth (*Laspeyresia molesta* Busck) which had passed the winter upon the ground.

The results of further work, in 1925, to determine the relative effectiveness of disking only as compared with plowing only and as compared with these two operations combined, demonstrated the equally high efficiency of a thorough cultivation consisting of disking alone.

In 1926 a final study was conducted to determine the relative numbers wintering *upon* the tree and *away* from the tree in order to establish the actual extent of the effectiveness of cultivation in the control of this insect. The results of this study indicate the following distribution of the overwintering population under present average conditions in New Jersey—14 per cent in the upper portions of the tree, 11 per cent on the tree trunk and 75 per cent away from the tree—percentages correlated with the abundance of mummies and applicable elsewhere subject to variances in infestation and orchard practice. It was also determined that of those larvae overwintering upon the tree trunk 88 per cent constructed hibernacula within the area included in the mound formed when applying paradichlorobenzene for the control of the peach-tree borer, an insecticide also toxic in the case of this insect.

These studies, although disclosing the fact that cultivation and the paradichlorobenzene treatment should destroy a high percentage (86%) of the hibernating Oriental Peach Moth, indicate an overwintering population in the upper portions of the tree sufficiently large to constitute a continuance of infestation from year to year in spite of the thorough application of these measures.

The knowledge of the relatively unprotected character and location of these remaining hibernacula suggests the advisibility of further work with insecticides of a penetrating nature, with the attendant possibility of placing the control of the insect largely if not wholly within the dormant period.

Throughout the entire course of the investigation of the Oriental Peach Moth in New Jersey, up to the present time, cultivation in the spring of the year as an effective method for reducing the overwintered numbers of this insect has received considerable attention. The results

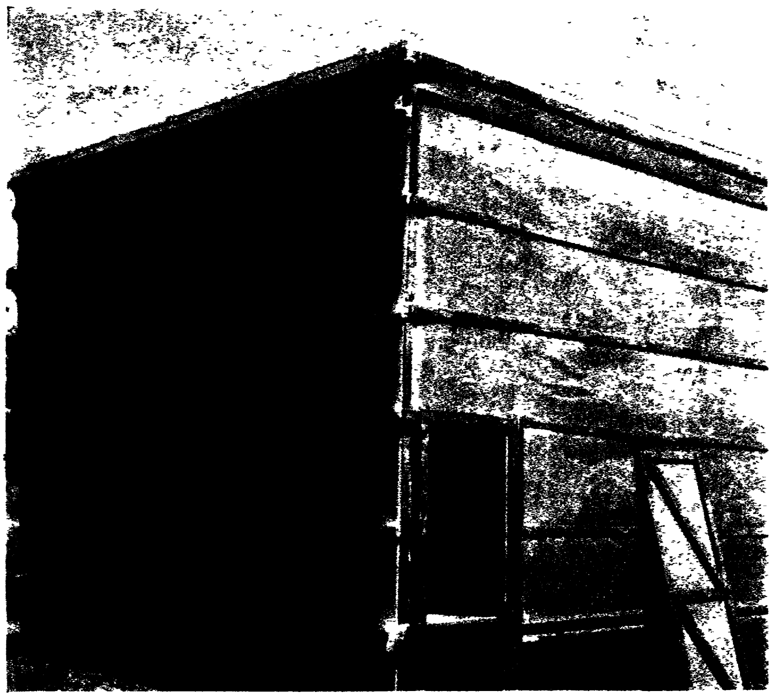
[1]Paper No. 333 of the JOURNAL Series, New Jersey Agricultural Experiment Stations, Department of Entomology.

of these control studies have been detailed in recent reports of the Department of Entomology of the New Jersey Stations, and elsewhere[2].

In 1924, experimental orchard cultivation supported later by laboratory tests, showed conclusively that thorough cultivation, during the latter part of the month of April, consisting of a plowing to the depth of six inches followed by a disking to the depth of four inches was 100 per cent efficient in the destruction of the larvae and pupae of this insect which had passed the winter upon the ground. The disinclination or inability on the part of many peach growers to use the plow necessitated further study in 1925, to determine the relative effectiveness of disking only as compared with plowing only and as compared with these two operations combined. The results of this work demonstrated the equally high efficiency of a thorough cultivation consisting of disking alone. Spring cultivation has been recommended, therefore, not only as an effective but also as a relatively economical control measure, since it did not interfere with established orchard practice aside from advancing the date of the turning-under of the cover crop.

These studies had been based, unfortunately, upon a supposition, that since the hibernacula can seldom be located in the upper portions of the tree and but occasionally in the crotches of the larger limbs and in crevices and rolls of bark and about the margins of exuded gum on the trunk, especially near soil level, the greater majority of the larvae must secrete themselves for passing the winter in and under trash (leaves, grass and weeds) and in and on mummies upon the ground beneath the spread of the tree. It was not until the present year (1926) that conditions were such that a careful study could be made to determine the relative numbers of larvae wintering *upon* the tree and *away* from the tree and to establish, thus, the actual extent of the effectiveness of cultivation in the control of this insect.

Details and Discussion. In this study which was conducted at the College Fruit Farm, at New Brunswick, nine peach trees, varying in age from 6 to 10 years and representing six mid and late season varieties, were employed. The selection was such as to include high, low and averaged-headed types as well as trees presenting extremes in the amount of trash and the number of mummies upon the ground. Each of the trees was enclosed in a 10'x10'x10' framework covered with a 32x28 mesh cotton gauze. (*Pl. 3, fig. 1*). These cages were so partitioned as to provide for the recording of separate emergence data for the three hibernating areas—the upper portions of the tree, the tree trunk and the surface of the ground beneath the spread of the tree. (*Pl. 3, fig. 2*). The records of emergence with additional data showing the correlation



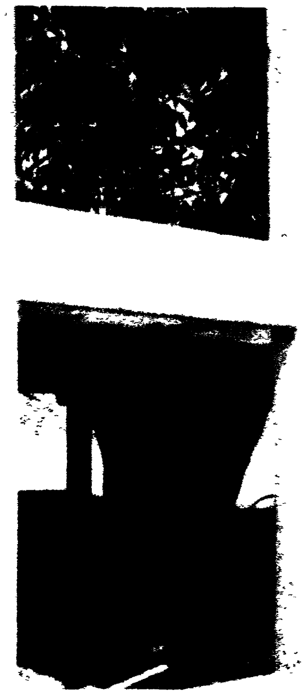
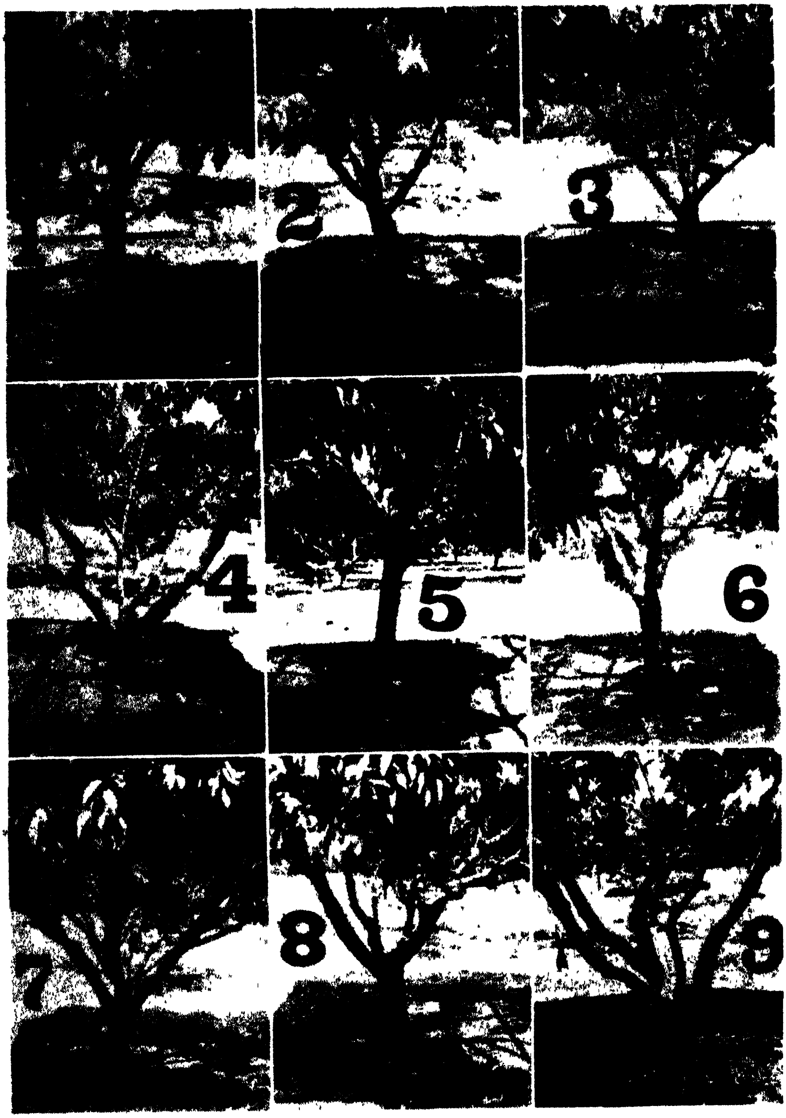


FIG. 1. Exterior and general construction of one of the nine cages employed in study of the hibernation quarters of the Oriental Peach Moth, New Brunswick, New Jersey, 1926.

FIG. 2. View through door of one of the nine cages employed in study of the hibernation quarters of the oriental Peach Moth, showing partitioning to segregate emergence records for the upper portions of the tree, the tree trunk and the ground beneath the spread of the tree New Brunswick, New Jersey, 1926



Nine peach trees employed in study of the hibernation quarters of the Oriental Peach Moth showing details of heading and branching, New Brunswick, New Jersey, 1926.

between the number of mummies and the per cent hibernating away from the tree are presented in Table 1.

TABLE 1. RECORDS OF EMERGENCE OF SPRING BROOD ADULTS OF THE ORIENTAL PEACH MOTH IN CAGES ENCLOSING NINE 6- TO 10-YEAR OLD PEACH TREES, NEW BRUNSWICK, NEW JERSEY, 1926

Tree	Varieties	Number from upper portions of tree	Number from tree trunk	Emergence Surface of ground beneath spread of tree: Number	Number of mummies	Per cent of total emergence in cage
1	Elberta	2	0	0	31	0.0
2	Osprey Improved	4	5	0	38	0.0
3	Krummel's October	6	3	1	68	10.0
4	Late Champion	4	10	1	72	*6.7
5	Krummel's October	10	6	4	78	20.0
6	Krummel's October	3	1	2	96	33.3
7	Heath Cling	2	0	6	107	75.0
8	Heath Cling	1	0	4	122	80.0
9	Lippiatt's Late Red	7	1	6	131	*42.9
	Totals	39	26			
	Averages	4.3	2.9			

*See discussion.

The data in *Table 1* indicate an average total overwintering population of four individuals in the upper portions of the tree and three on the tree trunk, records, which it is believed, represent with approximate accuracy the situation in this orchard under existing conditions of infestation. The additional data included in this table suggests a definite correlation between the number and percentage hibernating away from the tree and the presence or absence of mummies. With the exception of trees 4 and 9, which were the lowest-headed of the group and which present a branching type affording unusually favorable cocooning quarters on the tree (*See Plate 4*), the percentage hibernating away from the tree was directly proportionate with the number of mummies present on the ground. It will be noted further that this percentage increases rapidly with rather insignificant increases in the number of mummies. Inasmuch as the trees were deliberately selected to include a gradation in the number of mummies, the record of three which might be figured from the data in the table to represent the average total population overwintering away from the tree, would express inadequately actual conditions. Records show that under present average

[2]Ann. Repts. Dept. Ent. N.J. Agr. Exp. Stas. for the years ending June 30th, 1925, and June 30th, 1926; Proc. Ann. Meeting N. J. State Hort. Soc. November, 1924, and December, 1925; Jour. Econ. Ent. Vol. 18, No. 1, Feb. 1925, pp. 191–199.

conditions in New Jersey in excess of one hundred mummies per tree is a normal occurrence. The results of this study would seem to indicate, therefore, the following distribution of the overwintering population—14 per cent in the upper portions of the tree, 11 per cent on the tree trunk and 75 per cent away from the tree, percentages applicable elsewhere subject to variances in infestation and orchard practice.

With the number of individuals hibernating and emerging from the upper portions of the tree and the tree trunk known, a careful search was made to ascertain the exact location of the hibernacula. The resulting data has been summarized in *Table 2*.

As will be seen by reference to *Table 2*, it was possible to locate all hibernacula on the tree trunk. In the case of those in the upper portions of the tree on the other hand, and notwithstanding the fact that the search was greatly facilitated by the presence of the empty pupal cases protruding from the cocoons, only one-third of the total number emerged could be located. Observations made on the character of these hibernacula show that in the vicinity of 40 per cent were located on but slightly roughened surface bark in such exposed positions as to be wholly unprotected from a drenching dormant spray.

TABLE 2. RECORDS OF LOCATIONS OF HIBERNACULA OF THE ORIENTAL PEACH MOTH ON 6- TO 10-YEAR OLD PEACH TREES, NEW BRUNSWICK, NEW JERSEY, 1926

Vertical distance from ground (soil level)	Upper portions of tree Number	Tree trunk Number	Tree trunk Per cent
0″		6	23.0
1″		1	27.0
1½″		8	58.0
2″		1	61.5
2½″		2	69.0
3½″		1	73.0
4″		2	80.0
6″		2	88.0
1′0″		2	96.0
1′10″		1	100.0
2′3½″	1		
2′4½″	1		
2′7″	1		
2′8″	1		
3′3″	1		
3′8″	2		
4′0″	4		
4′6″	2		
Totals	13	26	
Percentages of total moths emerged	33.3	100.0	

It is especially significant from the control standpoint that of those larvae overwintering upon the tree trunk 88 per cent had constructed hibernacula within the area included in the mound formed when applying paradichlorobenzene for the control of the peach-tree borer. Not only has it been shown under controlled conditions that the larvae of the Oriental Peach Moth also succumb to the effects of this insecticide[3], but it is a common occurrence to record an abnormally high mortality for larvae on the trunks of trees in orchards where paradichlorobenzene is applied annually which can be ascribed to no other cause.

CONCLUSIONS. These studies, although disclosing the fact that cultivation and the paradichlorobenzene treatment should destroy a high percentage (86%) of the hibernating Oriental Peach Moth, indicate an overwintering population in the upper portions of the tree sufficiently large (14%) to constitute a continuance of infestation from year to year in spite of the thorough application of these measures.

The knowledge of the relatively unprotected character and location of these remaining hibernacula suggests the advisability of further work with insecticides of a penetrating nature, with the attendant possibility of placing the control of the insect largely if not wholly within the dormant period.

MR. H. L. DOZIER: I feel a few remarks here might be appropriate. We in Delaware during the past season have concentrated every effort on the clean-up of the codling moth, and in a study of sources of infestation of that insect, I ran across some interesting data in regard to the oriental peach moth carry-over.

In regard to the question of packing house sanitation or clean-up of old infested baskets, I might state I believe that that probably is one of the big factors which led to a surprising reduction in codling moth in the state of Delaware this year. For example, in one packing house we placed 3000 old five-eighth bushel picking baskets in the packing house cellar and kept everything tight above and below. We curtained off all but two of the cellar windows, so that the moths were mostly attracted to the light coming from these two windows, and we placed fly paper there. This fly paper was examined at intervals and the different proportions of the moths noted. On June 10, from fly paper exposed during the previous forty-eight hours, I counted 535 oriental peach moth adults as against 85 adults of the codling moth.

[3]*Laspeyresia molesta* Busck as a Quince Pest, E. N. Cory. Jour. Econ. Ent. Vol. 18, No. 1, February, 1925, pp. 199–203 (Tests conducted at temperature of 80°F).

That gives you an insight into just where some of the oriental peach moth is coming from outside of just what goes on around the tree.

Out of these 3000 baskets, I made a count of 389 of them, showing an average infestation per basket of 29.08 and one basket had 118 worms. That shows you that if 3000 baskets averaging nearly 30 worms were allowed to go out into the field or stand around in the open packing house, you would have 90,000 adult moths turned loose right there, and by taking care of them you have a reduction of that many with which to start off the season.

These baskets had been used for a very short period of harvesting some peaches and later used for two months picking late apples. The majority of the oriental peach moth adults coming out of those baskets, I believe, came from infested apples.

Professor Cory will have more to say about that subject in his paper.

In another packing house 3000 baskets were kept very tight, and on a count of 168 of those baskets, they averaged 21.4 to a basket. In a third packing house cellar about a thousand baskets were placed down in the cellar and a count of 100 of those baskets averaged 13.73 worms per basket.

That just gives you some figures on what I believe to be one of the prime factors in the reduction of the codling moth and one that has been often neglected by the entomologists. Pay more attention to the clean-up of the old baskets and I think you will get better results.

First Vice-President C. J. Drake: The next paper is by E. N. Cory and H. S. McConnell. Dr. Cory read the paper.

LASPEYRESIA MOLESTA AS AN APPLE PEST

By Ernest N. Cory and H. S. McConnell, *College Park, Md.*

Abstract

The extent of injury to apples, types of feeding, egg laying habits and late egg parasitism.

Laspeyresia molesta has been reported[1] as a pest of apples but in the experience of the authors has never attained the commercial damage heretofore in Maryland that it has occasioned this past season.

Examination of the orchard at College Park about the first of October showed a peculiar type of injury at the stem end in a large per cent of the cull fruit examined. Frequently this injury was a small split or abraded place near the base of the stem. Sometimes the injury was almost completely hidden by the stem being in contact along one side.

[1]Trans. Peninsula Hort. Society. 1925. p. 61.

In all cases, however, careful examination showed minute particles of frass near the base of the stem.

Further examination disclosed that many fruits had minute particles of frass almost hidden by the calyx lobes. On cutting these injured fruits larvae in all stages, but principally in the early instars, were found. The tunnels were of two types. Usually the larvae burrowed through the fruit towards the seed cavity, sometimes directly; at other times winding channels were cut and often the entire seed capsule was destroyed, together with some of the seeds, as well. The second type followed the characteristic tunnelling of the lesser apple worm just beneath the skin. These areas ran from the size of a dime to mines extending from the stem to near the calyx and involved nearly a quarter of the surface. When more than one larva was present, the apple broke down completely through a combination of soft rots and the feeding by the larvae.

In leaving the fruit the worm usually cuts a sharply defined circular exit hole, often near the stem or calyx end and constructs its hibernaculum in the basin between adjacent fruits or between the slats of the basket or in the pad.

This injury at College led to examination of cull apples from every part of the state except the extreme western counties. The apples showing evidence of worms were cut, the larvae collected and determined. The following table shows the relative proportion of codling moth and oriental fruit moth larvae in cull fruits.

TABLE 1. WORM COUNTS FROM CULL APPLES

No. of orchards	Total fruits	Visibly wormy	No. worms found	*C. pomonella*	*L. molesta*
12	2210	284	104	32	72
		12.8%		31%	69%

Examination of fruit from an experiment conducted at College, in a privately owned orchard, that had not been sprayed for about five years, showed the following ratio between codling moth and oriental fruit moth.

TABLE 2. WORM COUNTS FROM RECORD TREES IN EXPERIMENTAL PLOTS

Total Fruits	*C. pomonella*	*L. molesta*
5939	60	325
Per cent of total	1	5
Ratio	19	81

Another interesting observation on the cull fruit was the presence of eggs and egg shells on a large per cent of the fruit. Many of the eggs

showed evidence of having been parasitized, but our observation on the point was too late to yield the parasite itself. Most of the eggs were on the edge of either the stem or calyx basin.

Mr. H. L. Dozier: I am afraid that I might leave a little different impression than I intended and had better add a few remarks here. That proportion of 535 oriental peach moths to 85 codling moths was on June 10. Two weeks later the proportion of oriental peach moths coming out dwindled and the codling moth increased, so that when you got down to about three weeks later you got the oriental peach moth far less in abundance than the codling moth in the number coming out, showing that the oriental peach moth was much earlier in its habits in coming out in the spring than the codling moth.

Mr. Alvah Peterson: I would like to make a few statements which will corroborate what Professor Cory has said in respect to infestations of the oriental peach moth in fruits other than peaches. During the past season we examined a number of varieties of apples starting with summer fruit. Practically no oriental peach moth larvae were found in any variety earlier than Staymans. Wormy fruit was collected in the orchard, brought to the laboratory, the larvae removed and the species determined, so far as possible. Larvae removed from Stayman apples from one orchard appeared to be 52 per cent oriental peach moth larvae while in another orchard they ran close to 30 per cent and in another orchard 5 per cent.

Upon examining Kieffer pears close to 75 per cent of the worms removed were oriental peach moth larvae. Quinces ran 100 per cent infested, 5 to 35 larvae per fruit were common.

I would like to ask Professor Cory how early in the season did he start to examine fruit and what were the varieties?

Mr. E. N. Cory: These records are based mainly upon Stayman, Jonathan and Delicious. We didn't observe any injury in the early season, and it was only when we began to get our records from our experimental work that we found this injury, and then began to cut the larvae out and determine them.

Mr. J. A. McCarl: I would like to ask Professor Cory just how they determine what larval characteristics they have between the peach moth, codling moth and apple worm. Three years ago I submitted samples and was unable to get a determination.

Mr. E. N. Cory: We base our determination upon a key provided by Dr. Garman, While we realize there is no set of characteristics that will

separate the lesser apple worm from the oriental fruit moth, we believe that the matter of size and coloration of the lesser apple worm at that time of the year gives a pretty good determination.

MR. C. R. CUTRIGHT: I would like to ask if there is any difference in the degree of infestation between the different varieties.

MR. E. N. CORY: I don't believe there is any difference in those varieties that I mentioned. There is a difference apparently in the varieties that are known as winter apples. We had other apples in there; we had York Imperial and a number of others in lesser quantities, but there didn't seem to be very much difference between the grade of infestation, for instance, in Stayman and Jonathan. We had a fewer number of Delicious, and it would be hardly fair to say whether there was a difference there or not, but with the Jonathan and Stayman we had enough of equal distribution; I think there is no difference between those two. We also found infestation in Grimes and in Golden Delicious, but we didn't include those in these records.

FIRST VICE-PRESIDENT C. J. DRAKE: The next is a paper by T. L. Guyton.

NOTES ON THE OCCURRENCE OF *LUPERODES THORASICUS* AS AN INSECT PEST OF FRUIT TREES

By T. L. GUYTON, *Bureau of Plant Industry, Harrisburg, Pa.*

ABSTRACT

Luperodes thorasicus, a small, dark beetle formerly not known to occur in numbers sufficient to cause any economic concern was found in an orchard in the central part of Pennsylvania doing damage to the foliage of peach, apple and plum, and damaging slightly the fruit of apple. The owner of the orchard reported that the insect had been present for three or four years, and was increasing in numbers. A survey of the surroundings of the orchard showed the insect to be present on butternut (*Juglans cinerea*), and cultivated blackberries. Since the regular apple spray schedule was fairly closely followed in this orchard it may be that should this beetle increase it might become a serious pest in our orchards. The life history of the insect is not known.

In 1925 correspondence was received from Mr. George Lincoln of Clarks Summit, Pa., to the effect that an unknown beetle was causing him serious damage by feeding on the leaves of apple and young peach. He, also, said that the insect was attacking the fruit of apple. Again in 1926, Mr. Lincoln wrote to the department stating that the insect was appearing in large numbers again. On July 19th the orchard was visited. The beetles were found on the foliage of peach, apple and plum in rather abundant numbers. It was doing considerable damage to the foliage of peach, slightly less on certain apple trees, and but little

on the European plums. The fruit of one variety of apples, the Alexander, was considerably marked by feeding of the beetles. Some beetles were taken by beating with an insect net in the weed patches on the border of the orchard; and several specimens were found on the blackberry. They were rather numerous on the foliage of the white walnut, (*Juglans cinerea*). Mr. Lincoln said this insect had been present in his orchard for three or four years, and he believed that it was increasing in numbers. The orchard is in a sod mulch, is of about ten acres in area, and is bordered on one side by a strip of woodland in which a number of butternuts are growing. There are, also, large numbers of blackberries growing in and near the orchard. The orchard was sprayed at regular intervals following out the standard spray schedule for apples. The peach trees affected were small, being two years planted.

The identification of the species as *Luperodes thorasicus* Melsh. was made by Mr. A. B. Champlain of the Bureau of Plant Industry, and specimens were sent to the United States Department of Agriculture at Washington for confirmation. The species was described by Melsheimer in 1847 from specimens taken in Pennsylvania. LeConte in 1865 gave the distribution as Pennsylvania, Georgia, and Kansas and the occurrence rare. Horn in 1893 states that the species is widely distributed, but does not seem common. He gives its distribution as Pennsylvania, Maryland, Georgia, and Kansas. The writer was unable to find any other references to the species. It may be that this species is capable of becoming a serious pest in orchards since it was present in this case in rather large numbers in spite of the fact that the orchard had been well sprayed with the regular apple orchard sprays.

First Vice-President C. J. Drake: We wiill now listen to a paper by G. A. Runner and J. R. Eyer. Mr. Eyer will read the paper.

EXPERIMENTS IN CONTROL OF THE ROSE-CHAFER, *MACRODACTYLUS SUBSPINOSUS* FAB., IN VINEYARDS

By G. A. Runner, *U. S. Bureau of Entomology* and J. R. Eyer, *Pennsylvania Bureau of Plant Industry*

Abstract

During the last four years cooperative experiments have been carried on in Ohio and Pennsylvania in which some of the more recently developed insecticides were tested and compared with the arsenate of lead and molasses mixture ordinarily used for rose-chafer control. The following materials were included: emulsions of pyrethrum, ortho-

toluidine, and lubricating oils; lime sulfur in dust and liquid form; sodium fluosilicate; nicotine and tobacco dusts; coated (oleate), arsenate of lead, colloidal arsenate of lead, and dry arsenate of lead alone and in combination with Bordeaux mixture, wheat flour, molasses, and confectioner's glucose. Two methods were used to ascertain the effectiveness of these materials: (1) counts of the number of living adults were made on selected vines in each plot before applying the insecticides and these were repeated each day for a period of one or two weeks, depending on period of activity; (2) equal numbers of adults were placed in cages on vines in each plot and the living and dead recorded each day. The amount of injury due to feeding was also noted.

All of the arsenicals tested were toxic to the rose-chafer when used in sufficient amounts. Many of them did not protect the fruit and foliage from feeding injury because the adults ate large quantities of the leaves and fruit clusters before ingesting sufficient aresnic to kill them. In the case of arsenate of lead and molasses the beetles consumed toxic quantities without injuring the fruit or foliage and protection to the vineyard was almost perfect. With both arsenate of lead and flour, and coated (oleate) lead arsenate similar behavior was noted. Arsenate of lead: 4 lb., molasses. 2 gal., and water: 100 gal., killed caged adults in 24–48 hours and reduced infestation in the vineyard to an inappreciable amount. Doubling the amount of the arsenical increased the death rate in caged material but afforded no additional protection in the field. The time for applying these arsenicals proved exceedingly important. The best control was secured by spraying when the adults first migrated into the vineyard and commenced feeding. Weather factors, particularly low temperatures, also influenced the control obtained from the sprays.

Dusts of sodium fluosilicate and hydrated lime or talc were only slowly toxic, did not protect the vines against feeding, and burned the foliage unless large quantities of the diluent were used. Pyrethrum soap emulsion was highly toxic and killed 80–100 per cent of the beetles in twenty-four hours after spraying. It did not prevent injury to the vines from incoming migrants however. Orthotoluidine emulsion was more slowly toxic requiring several days to kill caged adults. The other materials tested were only doubtfully effective or entirely valueless.

A number of attrahents including essential oils, alcohols, and fruit juices were exposed in bait pans in infested vineyards. The rose-chafer was attracted by none of these materials.

First Vice-President C. J. Drake: The next paper is by Philip Garman.

THE PROBLEM OF CURCULIO CONTROL IN CONNECTICUT APPLE ORCHARDS

By PHILIP GARMAN

ABSTRACT

This paper treats of field experiments and observations showing different phases of curculio (*Conotrachelus nenuphar*) control, especially comparisons of seven-day applications with other schedules from which this spray is omitted. Figures show a small, consistent gain in clean fruit where the seven-day application was included in the schedule over those in which it is omitted. Other spray schedules are also compared and percentages tabulated. A variation of about ten per cent clean fruit was obtained by the different treatments, which was, however, very small and of doubtful importance in many cases. Some data indicate that fish oil used as a sticker at the calyx period gave almost as good results as where the complete schedule was used, and it appears possible to lessen the number of sprays for curculio control by this means.

Several years ago the Connecticut Station began a study of curculio control in order to fit methods of practice more closely to field conditions. It has been noted in various local experiments that a large per cent of the fruit, especially on outside rows, was often damaged even with the best methods of control available. Consequently investigations were begun along the lines needed to determine (1) the source or sources of the infestation and the time when it is at its height, and (2) the proper means of reducing it to a minimum.

Counts were made of drop fruits and beetles were reared from them, the number of larvae obtained indicating enough development in early drops to produce an ample supply of beetles the following year. Investigation of woods near apple orchards usually showed the presence of wild apples supplying additional beetles to the orchards in question. Our records indicate that beetles emerge from the soil beginning the latter part of April and continuing well into June—or in terms of the development of the tree they begin to emerge shortly before the blossom buds of most varieties turn pink, and continue at least two weeks after the petals have fallen. Our jarring records, however, indicate that they do not appear on the trees until shortly before the petals fall, and it has naturally occurred to us to ask this question—what is the value of poison for curculios applied at the pink bud period? By a continuation of jarring it has become apparent that the maximum abundance of beetles[1] on the trees in Connecticut may lie at least three weeks after the calyx or petal fall spray and we were led by these results to raise the second question—why should sprays grouped on the early side of the peak

[1]These data seem to correspond with data given by Quaintance, U. S. D. A. Bull. 103, p. 121, 1912.

provide greater protection than sprays grouped so as to spread the applications over the entire period of activity? We have attempted to answer these questions by means of spray schedules in which one after another of the important sprays were dropped, in order to determine what would be the effect upon the amount of clean fruit. The results of these experiments are shown in Tables 1–5. In view of the recent development of more efficient stickers, we have also considered the question of introducing one of these at a given point in the schedule (the calyx spray period) and noting results. Thus far they appear to be promising, as will be seen in Tables 3 and 5, and it seems reasonable to expect that something of this sort will result in the elimination of at least one of the early sprays from the schedule now recommended. In comparison of results in Table 5 it will be noted that there has been for three years a consistent advantage of two to nine per cent in favor of the 7-day practice schedule over that in which it is omitted. There seems to be a difference of opinion as to whether such an increase, in which the damage consists of one or two external scars per apple, will justify the expense of an extra application. Whether it is justified or not will, of course, depend upon the amount of fruit borne by the orchard in question, the market price of the scarred and first grade fruit, and finally the price of labor and materials. Other factors also enter the problem, namely the degree of increased control of other pests and the thoroughness with which the orchardist applies his materials. It does not seem justified in Connecticut at the present time except in the case of the best varieties of fruit and a large crop.

EXPLANATION OF TABLES. All spraying was done with rods, applying 8 to 14 gallons per tree. Trees in the orchards used were set about 1911. No counts are recorded where the apple crop consisted of less than a thousand fruits, the maximum in some cases reaching 54,000. The different treatments recorded as "no pink," "no calyx," etc. indicate omission of these sprays from the usual schedule. The figures in Tables 1 and 2 under "total per cent clean" are not the average of the drop and picked fruit percentages, but are figured on the basis of total fruits scored. The spray formulae used in each case consisted of the following except where indicated in the tables.

FORMULA NO. 1

Lead arsenate	3 pounds
Nicotine sulphate	1 pint
Casein lime	1 pound
Lime sulphur (dry)	6 pounds
Water	100 gallons

FORMULA NO. 2

Fish oil	1 quart
Lead arsenate	3 pounds
Water	100 gallons

No nicotine sulphate was used in any of the treatments in 1926. No lime-sulphur, or nicotine sulphate, or casein lime was used in any application containing fish oil.

Equal credit for the work herein reported is due to Mr. M. P. Zappe of the Connecticut Experiment Station, who has given much time, thought, and energy to the project.

TABLE 1. SHOWING COMPARISON OF DIFFERENT SPRAY TREATMENTS 1924

Treatment	Kind of fruit	Per cent clean	Total per cent clean
No pink spray;	Drops	62.5	
Calyx, 7-day, and 2-weeks	Picked	83.9	80.5
No calyx spray;	Drops	61.6	
Pink, 7-day, and 2-weeks	Picked	82 5	72.2
No 7-day spray;	Drops	85.2	
Pink, calyx, and 2-weeks	Picked	85.6	85.5
No 2-weeks spray;	Drops	60.0	
Pink, calyx, and 7-day	Picked	88.8	82.68
All sprays;	Drops	80.1	
Pink, calyx, 7-day, and 2-weeks	Picked	90.7	86.8
Check; no spray	Drops	31.6	
	Picked	39.1	35.9

TABLE 2. SHOWING COMPARISON OF DIFFERENT SPRAY TREATMENTS 1925

Treatment	Kind of fruit	Per cent clean	Total per cent clean
No calyx;	Drops	94.35	
Pink, 7-day, and 2-weeks	Picked	90.39	91.04
No 7-day;	Drops	83.07	
Pink, calyx, and 2-weeks	Picked	85.54	84.80
No 7-day;	Drops	95.60	
Pink, calyx with fish oil, 2-weeks	Picked	93.30	93.93
No 7-day; Pink, heavy dose[1]	Drops	41.66	
Lead arsenate at calyx and 2-weeks	Picked	91.47	88.33
No 2-weeks;	Drops	81.21	
Pink, calyx, and 7-day	Picked	92.34	89.66
All sprays;	Drops	92.08	
Pink, calyx, 7-day, and 2-weeks	Picked	94.60	93.77
Check; No treatment	Drops	43.98	
	Picked	35.66	38.78

[1]6 pounds per 100 gallons.

TABLE 3. SHOWING COMPARISON OF DIFFERENT SPRAY TREATMENTS
1926. Picked Fruit

Treatment	Per cent clean
No pink; calyx, 7-day, and 2-weeks	95.4
No calyx; pink, 4 days after calyx, 5 days later, 12 days after 5-day	90.6
No 7-day; pink, calyx, and 2-weeks	94.6
No 7-day; pink, calyx, with fish oil, 2-weeks	95.3
No 7-day or 2-weeks; pink, calyx with fish oil, nothing after calyx..	96.8
All sprays; pink, calyx, 7-day and 2-weeks	96.7
Check; no treatment	50.7

TABLE 4. SHOWING COMPARISON OF 7-DAY SPRAY WITH A SPRAY APPLIED AFTER THE REGULAR SCHEDULE

Treatment	Per cent clean
1925	
7-day; pink, calyx, 7-day, and 2-weeks	79.27
5 weeks; pink, calyx, 2-weeks, and 5-weeks	72.57
Check; no treatment	22.08
1926	
7-day; pink, calyx, 7-day, and 2-weeks	96.5
4-weeks; pink, calyx, 2-weeks, and 4-weeks	96.7
Check; no treatment	73.4

TABLE 5. SHOWING RESULTS OF DIFFERENT SPRAYS FOR CURCULIO CONTROL
1924, 1925 and 1926
Picked Fruit Only

Treatment	Per cent clean fruit		
	1924	1925	1926
Orchard A			
No pink; calyx, 7-day, 2-weeks	83.9		95.4
No calyx; pink, 7-day, 2-weeks	82.5	90.4	
No 7-day; pink, calyx, and 2-weeks	85.6	85.54	94.6
No 2-weeks; pink, calyx, and 7-day	88.8	92.3	
All sprays; pink, calyx, 7-day, and 2-weeks	90.7	94.6	96.66
Check; no treatment	39.1	35.6	50.7
No 7-day; fish oil plus lead arsenate at calxy (pink, calyx and 2-weeks)		93.3	95.3
Orchard B			
5-weeks spray; pink, calyx, 2-weeks, 5-weeks		72.5	
4-weeks spray; pink, calyx, 2-weeks, 4-weeks			96.7
Pink, calyx, 7-day and 2-weeks		79.2	96.5
Check; no treatment		22.08	73.4

MR. G. M. LIST: In this connection I would like to mention a little experience we have been having with this same insect in Colorado. For a number of years we have been watching it on the wild cherry in our foothills and to some extent on the sour cherries growing in orchards near the foothills. Two or three different times we have had it de-

termined as this species. We have been inclined to doubt the exact determination, but this year we had over twelve acres of cherries that were a total loss. As soon as the fruits were punctured by the adults, they, of course, were immediately attacked by bees and various flies and the orchard was simply humming with the insects.

I am wondering if any of the others have had experience with this in stone fruit. It was quite alarming to us in the cherry growing section there.

I might correct a wrong impression that I probably gave. When the speaker was speaking about the curculio in the apple, I thought, (being from the West) of the apple curculio, but I understand he was speaking of the plum curculio.

FIRST VICE-PRESIDENT C. J. DRAKE: The next is a paper by H. J. Quayle.

CYANIDE DUST FUMIGATION

By H. J. QUAYLE, *University of California, Citrus Experiment Station, Riverside, California*

ABSTRACT

In recent years new forms of cyanide have been developed which are known as cyanides of calcium. Such compounds are more or less unstable and advantage is taken of this property by simply exposing them, in a finely divided form, to the atmosphere in order to have hydrocyanic acid gas liberated. This method of fumigation particularly as applied to citrus was developed by the writer in California in 1922 and in the following year he introduced it into Australia where it has now largely replaced the older methods of fumigation. It is also used as an effective method of controlling the rabbit which is the leading pest of that country. During the past year a practically pure calcium cyanide has appeared which overcomes the chief objection to the first material in that the dust residue is not so injurious to the tree in sections having a moist atmosphere. Hydrocyanic acid in dust form escapes through canvas covers less readily than does the same gas from liquid hydrocyanic acid. The method of application is simply to blow the cyanide dust under the tented tree or space and the moisture of the air in contact with the dust particles generates the gas.

The form of cyanide first used for the fumigation of plants was potassium cyanide and this salt continued to be used exclusively for such purposes although the sodium salt was at the same time largely used in the industries. The late adoption of sodium cyanide for plant fumigation was probably due to the fact that it contained more or less sodium chloride which, as in the fumigation of plants hydrocyanic acid gas is the end sought for, resulted in the decomposition of a portion of this gas.

More recently other forms of cyanide adapted for fumigation purposes have appeared and in these the cyanogen is combined chiefly with

calcium rather than with potassium or sodium. Cyanides of calcium differ from the other cyanides heretofore used for fumigation in that hydrocyanic acid is freely liberated simply on exposure to the atmosphere. This less stable nature of the calcium cyanides makes them much more convenient for many kinds of fumigation work because the addition of sulfuric acid and water is unnecessary.

The first of these compounds is formed by the fusion of cyanamid with common salt. Upon learning in June 1922, that HCN gas was given off from the crude material, which is in the form of flakes, in sufficient amount to kill rodents it occurred to the writer that if the flakes were ground into a fine powder the liberation of the gas might be sufficiently rapid to be applicable for the fumigation of citrus trees; and providing furthermore that the dust residue would not be injurious. The first tests carried on during the dryer part of the year in southern California were successful, but under more moist conditions too much injury to the tree occurred, particularly with the lemon. It is a curious fact that while the lemon is much more resistant to HCN gas than the orange, with this method of calcium cyanide dust fumigation, the lemon is the more susceptible. The calcium cyanide which is now known on the market as cyanogas calcium cyanide contains a considerable amount of common salt, calcium carbide and other impurities.

In 1923 the writer had the privilege of trying the dust method of fumigation with cyanogas calcium cyanide under Australian conditions. A considerable portion of the citrus area in that country is probablv under dryer conditions than that of southern California, which would account for the fact that 300,000 citrus trees were successfully fumigated by the dust method in that country last year.

No one is long in Australia before he appreciates the great importance of the rabbit problem, and it seemed to me that cyanide dust gave promise of being a satisfactory fumigant. Carbon disulphide was the chief fumigant heretofore used. In fumigatorium experiments where ounces by weight of the cyanide were compared with fluid ounces of carbon disulphide, it was found that the cyanide was 35 times more deadly on the rabbits than the carbon. That is, if 1 fluid ounce of carbon disulphide was necessary to kill in a certain enclosed space only 1/35 of an ounce of the cyanide was necessary. In the use of carbon disulphide a smoke formed by an acid and ammonia is first pumped into the burrows to indicate the connecting openings. After these are closed the carbon disulphide is pumped in. In case of the cyanide when it is blown into the burrows the fine dust soon appears at the surface of all connecting burrows, so that the cyanide dust acts not only as the killing agent but

is also an indicator for open burrows. Calcium cyanide dust fumigation has proved to be an effective method of controlling the rabbit in Australia and a good many tons of the material are now used there annually.

But I am getting far afield, since citrus fumigation was my main problem. Further work with citrus dust fumigation was given up in California because under the best methods the hazard to the tree is great enough. However, during the past year another calcium cyanide compound in the form of a very fine powder has appeared. This product is formed by combining liquid hydrocyanic acid with calcium carbide. Since this is practically a pure calcium cyanide and the residue therefore should be less harmful to the tree, work on dust fumigation for citrus trees was resumed. This product, $Ca(CN)_2$, which is now known on the market as "citrofume" contains 30 per cent HCN. On exposure to the air HCN gas is given off rapidly. Where it was blown under a tent and collected on paper 93 per cent of the total gas was liberated within five minutes, 98 per cent in twenty minutes, and 99 per cent in forty-five minutes when the relative humidity was 57–58 per cent and the temperature 71°–74°F. When the relative humidity was 20–22 per cent, 90 per cent of the gas was liberated at five minutes, about 96 per cent at twenty minutes, and 98 per cent at forty-five minutes. The low relative humidity 20–22 per cent, had no marked effect on the evolution of gas from the citrofume but this humidity retarded considerably the evolution of the gas from cyanogas calcium cyanide.

Work with both of these dust cyanides has indicated that a less actual amount of HCN is necessary to put under the tent than is the case with the use of liquid HCN. Judging from the kill of scale alone it was thought that the distribution of the dust particles and the generation of HCN gas from them, often in close proximity to the scales, largely accounted for this fact. But by aspirating a quantity of air from under the tent at different places and at different times, and determining the actual amount of HCN gas present it appears that less of the gas goes out through the tent where it comes from the dust than where it comes from the liquid.

For example a considerable number of field tests have shown that 1¼ ounces of $Ca(CN)_2$ (30 per cent HCN), so far as the actual mean gas concentration and the kill of scale under a tented tree are concerned, are equal to 20cc. of liquid HCN of 97–98 per cent purity. One and one-fourth ounces of this calcium cyanide would also equal about 1 ounce of sodium cyanide (51–52 per cent cyanogen). In the amount of calcium cyanide given there is about ¼ less HCN than in the amount of liquid given. If the mean concentration of HCN gas under the tent is the

same when these ratios are used then there must be less escape of gas in one case than in the other. Where a gas tight fumigatorium is used for the comparisons the differential indicated does not appear. That is, in order to secure the same mean concentration of gas in a tight box or room the equivalents of HCN must be carried in both the dust and liquid when the charge is given. Why HCN gas does not escape through the tent as readily in one case as in the other is largely speculative at the present time.

Another grade of $Ca(CN)_2$ carrying 50 per cent of HCN or "Calcyanide" has been tested to some extent for citrus fumigation, although at present it is prepared primarily for ware-house fumigation. Evolution of the gas is more rapid than with the lower grade or 30 per cent material. The higher grade or 50 per cent material would probably be preferable even for citrus fumigation, chiefly because there would be less bulk to handle, but thus far commercial citrus fumigation has been carried on with the 30 per cent material.

Calcium cyanide $Ca(CN)_2$ "citrofume" is well adapted for citrus and other fumigation because (1) HCN gas is readily and very completely evolved during the exposure period of 45 to 60 minutes, (2) it is in a fine state of division, thus insuring good distribution under the tent, (3) the residue is practically harmless, (4) it can be stored and kept indefinitely in air tight containers, (5) it is useful for occasional fumigation about any premises because it may be on hand and is simple to apply. (6) It is safe to handle and to transport. This is the important comparison in relation to liquid HCN; and in relation to the pot system, and the use of acid and water, convenience is the important consideration.

In citrus fumigation, by means of a hand applicator, the proper dosage is given by weight and the material is then blown under the tent by a foot bellows. This applicator has been largely discarded, however, for a power applicator which consists of a Ford chassis on which is mounted the weighing device and a pump operated by power taken from the Ford engine. A good many thousand pounds of material were used in this method of fumigation in California during the past year.

MR. C. A. WEIGEL: How much air is aspirated?

MR. H. J. QUAYLE: We aspirate three liters from three different points in the tree, and five of these aspirations are made during a period of forty minutes.

FIRST VICE-PRESIDENT C. J. DRAKE: Mr. Hartzell has come into the room so I will call for his paper.

THE ARSENIC CONTENT OF SPRAYED APPLES

By ALBERT HARTZELL and FRANK WILCOXON, *Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York.*

ABSTRACT

Individual analyses of 47 apples from trees sprayed according to the standard schedule comprising 5 applications of lead arsenate (4 lbs. to 150 gals.) at Yonkers, New York, during the season of 1926, gave an average of .173 mg. of arsenic trioxide per kg. of fruit and a maximum of .704 mg. per kg. The quantity allowed by the Royal Commission on Arsenical Poisoning in 1903, was 1.429 mg. per kg. of foodstuffs. There was between 17.85 and 19.51 inches of rainfall from the time the first spray was applied until the date the fruit was picked. Analyses of cider (50 cc.) and jelly (30 g.) made from apples from this experiment, showed arsenic in such minute quantities that the determinations did not differ from the blanks of the reagents by any measurable amounts.

Recently anxiety has arisen in England regarding the safety of sprayed fruit for human consumption. In that country fruit trees are sprayed when the blossoms are in the pink bud stage and sometimes immediately after the petals fall, or rarely a little later, but the frequent applications of arsenicals, as is common in the United States and Canada, is not the practice there. Apples showing spray residue began to attract the attention of the public and questions were asked in the House of Commons as to the danger of using such fruit. The Ministry of Agriculture (1) had a number of samples analyzed from England, Canada, and the United States. Of the 24 samples reported, one from British Columbia contained more arsenic trioxide than 1/100 grain per pound (1.429 mg. per kg.), the limit suggested by the Royal Commission on Arsenical Poisoning in 1903. The subject has been discussed at considerable length in newspapers and trade journals (2) and has led to a more stringent enforcement of the regulatory measures in the United States and abroad. The question of whether the amount of arsenic that remains on sprayed fruit at harvest time is sufficient to endanger public health and therefore necessitate a change in our spray program, is one of prime importance to the consumer, the fruitgrower and the entomologist. The present study is an attempt to briefly summarize our knowledge to date regarding arsenical residue on apples and present, in addition, the results of one season's work on analyses made of apple stems, peel, and calyx ends that received a definite spray schedule containing a known amount of lead arsenate and that were exposed to the rainfall during the season of 1926, of which records are available.

Le Baron (3) was the first to recommend the application of Paris green to fruit trees for the control of the spring canker worm, but spraying did not become a general practice until after 1887.

Cook (4) found no trace of arsenic in 100 blossom ends that were removed from the trees on August 19, that had been sprayed 4 to 5 weeks previously with London purple at the rate of one pound to 100 gallons of water.

In like manner Garman (5) obtained negative results from analyses of skins and ends of apples that had been sprayed with a single application of Paris green and 5 applications of London purple at the rate of one pound to 160 gallons of water.

In Europe the controversy over the use of arsenicals centered around the possible danger of the contamination of wine and considerable literature has been developed on this phase of the subject which need not be discussed here. The ordinance of 1846 prohibited the use of arsenicals in France but this seems not to have been enforced. After much controversy the Ministry of Interior in 1913, submitted to the Academy of Medicine a draft of a decree modifying the ordinance of 1846 and permitting the use of insoluble arsenates in agriculture under regulation, but prohibiting the application of soluble arsenical insecticides (6). This decree was presently put into effect.

Forbes (7) reported 36.6 and 32.9 parts per million of arsenic trioxide respectively from apple peel that had been sprayed with lead arsenate the previous day, and 40.1 parts per million from the skins of fruit picked two months after heavy spraying with lead arsenate.

Gunther (8) found 0.057 mg. arsenic trioxide per 100 g. (0.57 mg. per kg.) of fruit from apples sprayed with a mixture of 300 g. of sodium arsenite and 425 g. of lead acetate per 100 liters. He also reported results of analyses of apples that had been dusted with a mixture containing 2 parts of freshly slaked lime, 4 parts of sulfur, and 1 part Paris green. The arsenical content of the dusted fruit ranged from 0.420 mg. to 0.0084 mg. of arsenic trioxide (0.42–0.08 mg. per kg.). In both cases the materials had been applied from 80 to 160 days previous to analysis.

Brioux and Griffon (9) reported in September only a trace of arsenic from apples, and the cider made therefrom, that had been sprayed with lead arsenate on June 8 and 22. Representative samples taken in July showed on analysis 1.3 mg. arsenic trioxide per kilogram of fruit.

Amphola and Tommasi (10) state that food stuffs derived from plants sprayed with arsenicals always contain arsenic, usually in traces, but sometimes with fruit the amount may be as high as 2 mg. per kg.

Sonntag (11) concluded from the results on ripe fruit treated with arsenical mixtures, that sprays or dusts applied to fruit trees adhere to the fruit and are retained for a long time, in many cases until the ripening of the fruit. He recovered arsenic trioxide in weighable amounts from

fruit sprayed twice with Bordeaux-arsenate 87 days later, and from apples and pears 80 days after spraying with lead arsenate. With arsenical dusts appreciable amounts of arsenic trioxide were obtained 106 days after dusting. The results of his analyses appear to be somewhat higher than those obtained by any other investigator, although the fruit had been exposed to a number of rains before picking.

O'Gara (12) found that skins of apples will occasionally absorb arsenic, noticeable in the form of red or black spots, which upon analysis showed fractions of a milligram of arsenic.

Woods' (13) analyses indicate an average of .5372 mg. per kg. of arsenic trioxide per apple from washings of fruit that was sprayed in August and picked two months later. He concludes that the amount of arsenic that will remain on fruit at the end of this period is so slight as to have no practical bearing.

O'Kane, Hadley, and Osgood (14) recorded the following amounts of arsenic trioxide on apples that had been sprayed with lead arsenate at the rate of 3 pounds of the paste to 50 gallons of water: apples picked carefully 0.08 mg. to 0.77 mg.; 0.02 mg. to 0.50 mg. when picked in the ordinary way; 0.10 mg. to 0.21 mg. when picked with cotton gloves; and 0.08 mg. to 0.18 mg. when picked with cotton gloves and wiped. The maximum amount of lead arsenate, when sprayed directly, that would adhere to an apple, was found to be 4 mg., expressed as arsenic trioxide.

Lynch, McDonnell, Haywood, Quaintance, and Waite (15) conclude from the results of a large number of analyses of sprayed fruits that it is important to follow the spray schedule recommended by the U. S. Bureaus of Entomology and Plant Industry if excessive amounts of spray residue are to be avoided and when this schedule is followed there is little spray residue remaining on the fruit at harvest time. They found that in peeling the fruit practically all the spray residue was removed.

Sutton (16) found that when apple trees in Western Australia were sprayed as late as November with 12½ pounds of lead arsenate to 100 gallons of water, using flour as a spreader, the fruit when examined in February showed a maximum only of 1/8 of the minimum set by the British Ministry of Health (1/100 grain per pound). It was greatest when the largest amount of flour was used as a spreader. Where trees were sprayed 5 times with 6 pounds of lead arsenate in 100 gallons of water, with a calcium caseinate spreader, and the last spray applied in December, the amount of arsenic trioxide found varied from 1/110 to

1/800 grain per pound (0.013 mg. to 0.002 mg. per kg.). He states that the amount of rainfall after spraying was comparatively light.

Plan of Experiment

In order that the results would be significant for fruit growers in the vicinity of Yonkers, the strength of spray materials and the time of application of the sprays were made to conform as nearly as possible with those recommended by the local spray service. Twenty mature Greening apple trees were included in the test. Five regular spray applications were made, namely, the delayed dormant, blossom pink, calyx, two weeks and mid-summer. Grasselli powdered lead arsenate[1] at the rate of 4 pounds to 150 gallons of spray solution was used in all the applications. Lime-sulfur was used in the first four, but omitted from the last application, because scab infestation was light, practically none developing on the unsprayed trees. Full strength lime-sulfur 1–8, with a hydrometer reading of 1.03 sp. gr., was used for the delayed dormant and for the other three applications summer strength 1–40 (1.008 sp. gr.). Two pounds of calcium caseinate and 1½ pints of nicotine sulfate to 150 gallons of spray solution were included in all 5 applications. The spray ingredients were mixed in the following order: water, lime-sulfur, calcium caseinate, lead arsenate, and nicotine sulfate. The following schedule represents the spray program for this experiment. Owing to adverse weather conditions the "two weeks" spray was applied later than usual.

1926 Spray Program, Yonkers, New York

Period of spraying	Date of application	Materials in spray mixture
1. Delayed Dormant	April 22	Lime-sulfur, 15 gals. Calcium caseinate, 2 lbs. Lead arsenate, 4 lbs. Nicotine sulfate, 1½ pts. Water to make 150 gals.
2. Blossom Pink	May 11	Lime-sulfur, 3½ gals. Calcium caseinate, 2 lbs. Lead arsenate, 4 lbs. Nicotine sulfate, 1½ pts. Water to make 150 gals.
3. Calyx	May 25	Lime-sulfur, 3½ gals. Calcium caseinate, 2 lbs. Lead arsenate, 4 lbs. Nicotine sulfate, 1½ pts. Water to make 150 gals.

[1]A sample of the lead arsenate used in this experiment was found on analysis to contain 21.6 per cent metallic arsenic.

4. Two weeks	June 17	Lime-sulfur, 3½ gals. Calcium caseinate, 2 lbs. Lead arsenate, 4 lbs. Nicotine sulfate, 1½ pts. Water to make 150 gals.
5. Mid-summer	July 19	Calcium casinate, 2 lbs. Lead arsenate, 4 lbs. Nicotine sulfate, 1½ pts. Water to make 150 gals.

The sprays were applied by means of a 6 H.P. Friend sprayer. Spraying was done from the ground using a Friend gun, developing a pressure of 250 pounds at the nozzle. The trees averaged about 20 feet in height and the amount of spray applied per tree was approximately 25 gallons for each application. Insects were not unusually severe. The sprays gave a 97% control of codling moth which was the principal insect trouble. On September 14, 100 apples were picked from the upper branches of the sprayed trees; none were taken less than 12 feet from the ground. These are designated as series 1. A month later, series 2, consisting of 100 apples, was picked from the lower branches of the sprayed trees, within 8 feet from the ground. Care was exercised in picking to avoid unnecessary handling so as not to remove the spray residue. To prevent any loss in weight due to respiration, the apples were placed in cold storage at a temperature of 5°C. until they were ready to be prepared for analysis.

Climatic Factors

The spring of 1926 was unusually dry, the local weather records showing only 4 rainy days at Yonkers for the month of April; contrasted with this was the rather heavy precipitation during mid-summer and fall. From the time of the first spray, the delayed dormant application, which was made April 22, until September 14, when the first apples were picked (series 1), a total of 17.85 inches of rain fell. The total precipitation from July 19, the date of the last spray, until the time of picking, was 9.71 inches. The apples in series 2, which were picked a month later than those in series 1, were exposed to 19.51 inches of rainfall from the date that the first spray was applied to the time of picking, while the precipitation recorded for the time intervening between the last spray and the time of harvest for this series, was 11.37 inches. The daily precipitation, dates of spraying, and the length of time the apples were exposed to rainfall after spraying, are shown graphically in figure 9. The rather heavy rainfall during the latter part of this season must be taken into account in making comparisons of arsenic content of fruit. The results

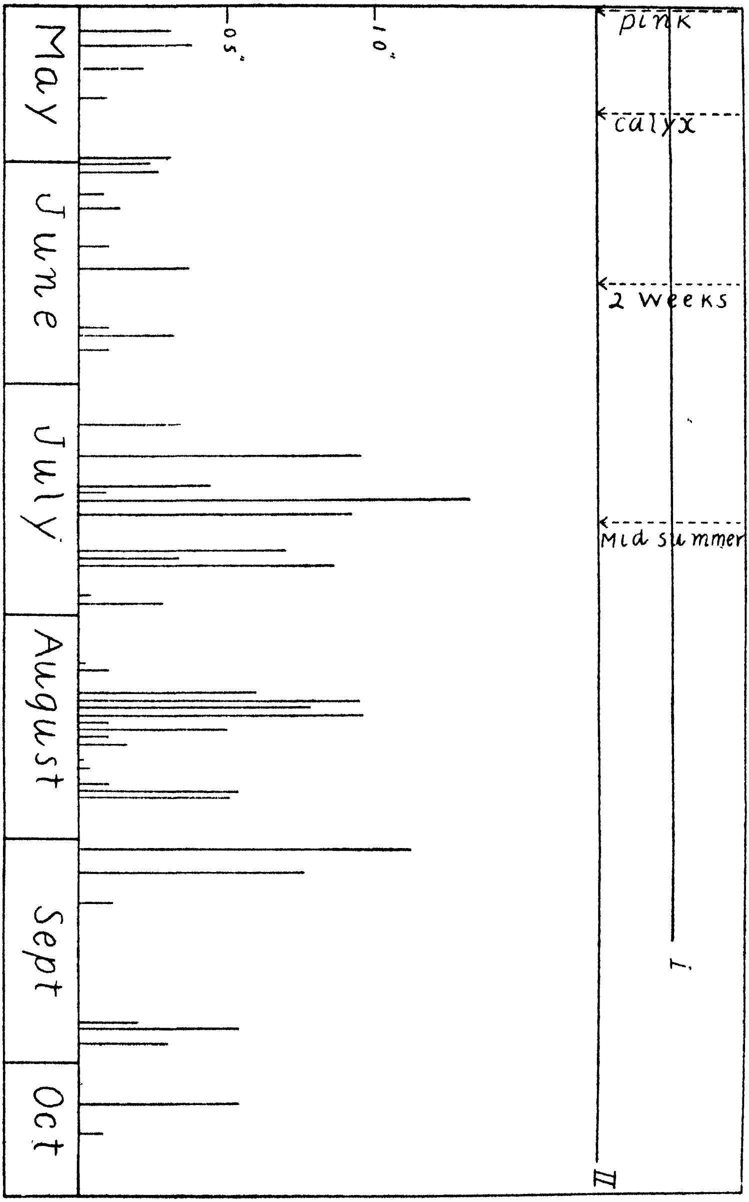


Fig. 9.—Graph showing dates of spraying, daily precipitation and time of sampling. Horizontal lines opposite Roman numerals indicate respectively the length of time the apples in series I and II remained on the trees.

are probably somewhat lower than would be expected for a season of normal precipitation, while during a dry fall, fruit would doubtless show a considerably higher arsenic content than was obtained this year.

Method of Analysis

It was desired to determine the arsenic content of individual apples rather than that of a sample containing a number of apples, since in the latter case unusually high values for a single apple might escape notice. As the quantity of arsenic on any one apple was very small, it was necessary to use a colorimetric method for its estimation. From each series 24 apples were selected at random, weighed and carefully peeled. Included with the peel was the stem and calyx, which were placed immediately in a Kjeldahl flask and digested with sulfuric and nitric acids until all organic matter was destroyed. After heating until fumes of sulfur trioxide were given off, the solution was diluted to 100cc. and 25cc. portions taken for the determination of arsenic by the modified Gutzeit method as described in Scott's "Standard Methods of Chemical Analysis."[2] Blank determinations were made on the reagents used, as well as on apples which had never received an arsenic spray, and a series of standards was prepared using the peel of unsprayed apples to which varying amounts of a standard solution of sodium arsenite were added. The blank on the reagents was small (0.001 mg. arsenic trioxide) and that on the unsprayed apples did not differ from it by any measurable amount. Using the smaller Gutzeit apparatus, it was possible to detect differences of 0.002 mg. of arsenic trioxide. The mean value for a single apple was approximately 0.026 mg.

Results

The results of the determinations were calculated to mg. arsenic trioxide per kg. of fruit and are given in Table 1.

In order to test the possibility of arsenic contamination of apple products, samples of jelly and cider were made. Ten unwashed apples from series 2 were carefully peeled and jelly made from the skins and cores according to the usual household method. Cider was made from 12 unwashed apples from the same series. A 30 g. sample of the jelly was used for analysis and a 50cc. sample of the cider. For comparison, cider (50cc. sample) from a commercial cider mill, made of sprayed apples from a local orchard, was also examined. The results of the examination in no case showed amounts of arsenic significantly greater than the blanks of the reagents.

[2]Scott, W. W. Standard Methods of Chemical Analysis, p. 40, D. Van Nostrand Company, 2nd Edition, 1918.

TABLE 1. ANALYSES OF ARSENIC REMAINING ON INDIVIDUAL APPLES AT PICKING TIME

Series 1 Apples taken from upper branches			Series 2[3] Apples taken from lower branches		
wt. grams	mg. As_2O_3 per apple	mg. As_2O_3 per kg. fruit	wt. grams	mg. As_2O_3 per apple	mg. As_2O_3 per kg. fruit
149	.003	.020	150	.004	.027
103	.020	.194	183	.012	.065
144	.015	.104	200	.050	.250
154	.006	.039	125	.016	.128
207	.006	.029	182	.024	.132
152	.005	.033	202	.004	.019
155	.075	.484	176	.024	.136
131	.010	.076	143	.048	.336
105	Trace	—	142	.100	.704
126	.015	.119	150	.068	.454
107	.012	.112	165	.048	.290
171	Trace	—	125	.060	.480
141	.008	.056	139	.060	.432
170	.030	.177	159	.008	.050
174	.008	.046	147	.060	.408
152	.020	.132	178	.008	.045
172	.040	.233	165	.024	.145
217	.008	.036	178	.032	.180
107	.030	.280	159	.050	.314
90	.032	.356	122	.004	.033
81	.010	.123	210	.100	.476
102	.002	.019	200	.024	.120
119	.004	.033	187	.040	.214
102	.004	.039			

CONCLUSION

It was found that apples sprayed this season according to a standard schedule, for this vicinity, contained arsenic in amounts considerably below the limit adopted by the Royal Commission on Arsenical Poisoning in 1903. The amount of arsenic from food products made from these apples was even less than that found in the original apples.

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[3]Series 2 consisted originally of 24 samples but one sample was lost on analysis.

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MR. E. R. VAN LEEUWEN: I should like to know how the samples were selected?

MR. ALBERT HARTZELL: We got a ladder, picked the apples and carefully handled them so as not to rub off too much of the arsenic. We tried to follow the method described by Professor O'Kane for ordinary picking.

MR. E. R. VAN LEEUWEN: Do you select the apple with the heaviest application on it?

MR. ALBERT HARTZELL: No. We tried to do that, but we found you can't always tell whether an apple has a large amount of arsenic on it. One that appears to have a fairly large amount of arsenic on it may test lower than one that does not appear so. We tried to pick those that seemed to have the largest amount of arsenic.

MR. P. M. GILMER: In checking over government apples analyzed by government chemists, we found that in apples collected by the same man in the same orchard, and as carefully sampled, and two or more apples sampled by chance, there were differences in the arsenical content

on government analyses of from about one-fourth British tolerance to about four times British tolerance. It seems from these results that deductions drawn from analyses of sample apples can be of no general value.

MR. ALBERT HARTZELL: I know there is a tremendous variation in the samples. We had samples ranging all the way from two-thousandths of a milligram up to almost eight-tenths, and we attempted to plot it on a frequency curve, but apparently it does not follow the ordinary frequency curve.

MR. E. R. VAN LEEUWEN: We took two samples of apples and picked out the worst we could find. We did that because we have done some work with the Food Inspection Division and they followed that method.

MR. ALBERT HARTZELL: Do you think that is superior to this?

MR. E. R. VAN LEEUWEN: I couldn't say at the present time.

FIRST VICE-PRESIDENT C. J. DRAKE: The next is a paper by D. F. Barnes and S. F. Potts. Mr. Barnes will read the paper.

AIRPLANE DUSTING EXPERIMENT FOR GIPSY MOTH CONTROL

By D. F. BARNES and S. F. POTTS, *U. S. Bureau of Entomology, Melrose Highlands, Mass.*

ABSTRACT

This paper discusses the infestation treated, the control secured, the poison distribution, and the relation of topographical and meteorological factors to the results secured.

In the season of 1926 a satisfactory experiment in the use of an airplane for dusting forest areas was conducted by the Bureau of Entomology. The problem presented was to apply sufficient arsenate of lead to kill the gipsy moth larvae feeding on the foliage. This implied uniform distribution over the treated areas.

The use of aircraft to apply insecticides was first undertaken in 1921 by the Ohio Experiment Station. In 1922 the Bureau of Entomology initiated two separate series of experiments in this work; one at the Delta Laboratory, Tallulah, La., and the other at the Gipsy Moth Laboratory, Melrose Highlands, Mass. The experiments at the Gipsy Moth Laboratory were not conclusive for the first two years. In order to cover forest foliage with a killing dose, large quantities of poison must be used, for which no satisfactory distributing apparatus was available. In addition, the infestation reached a low level in 1924, so that the project was held in abeyance.

In 1926 the project was resumed, and in the towns of Barnstable,

Falmouth and Sandwich, Mass. six plots of 25 acres each, with suitable checks, were laid out. These plots were located from 2 to 15 miles from a landing field at Sandwich. They were selected to give as great variation as possible in terrain and tree growth. A small two-room building at the field served for storage of supplies and as a temporary field laboratory. The laboratory was equipped with apparatus for testing the quantity of arsenate of lead on samples of foliage and with a self recording anemometer, thermograph, and hygrometer for securing weather data. However, no provision was made for obtaining rainfall records at the field as the precipitation records of the co-operative U. S. Weather Bureau observer at Hyannis, about 10 miles away, were available. Observations on the field conditions and results at the plots were facilitated by the use of a quadrat system with points of observation at 200 foot intervals. The system is illustrated in the sketch-plan of Plot 1, Sandwich. The intersection of any two lines established a point for observation. The tree nearest the intersection was used as a center tree for the point, and marked with a three inch band of white paint, together with the letter and number of the intersecting lines, e. g., G-4.

The Sandwich 1 plot may be taken as typical, since it represents the average Cape Cod conditions in regard to topography, weather, and type of growth. It contained 66 acres, 25 treated and 41 untreated, with 91 observation points, 24 in the treated section and 67 in the check. The accompanying sketch shows the relationship of the treated and untreated portions, and indicates by contour lines that the plot was high at both ends, with a valley of three or four acres near the center. The growth, mostly white and scarlet oak, with occasional pitch pines, varied from 10 to 30 feet in height; the canopy was medium to dense. A count of egg clusters, made at each observation point, gave an average of about 13,000 per acre. A sample egg collection showed about 25 per cent parasitism and 60 per cent hatch. Larval and pupal collections made throughout the season showed a small amount of parasitism. Observations made at the height of feeding showed that in spite of egg and larval parasitism there were enough larvae in the plot to completely defoliate it if no treatment had been given.

The first application was made on June 11 between 6:30 and 8:30 p. m., eastern daylight time. At this time about 55 per cent of the larvae were in the third stage, 40 in the second and 5 in the fourth stage. The plane made three trips to distribute the 1000 pounds of dust necessary to treat the plot at the rate of 40 pounds per acre, taking 82 minutes in the air to complete the work. On account of mechanical difficulties with the hopper the number of swaths to deliver one load varied from

8 to 18. The plane flew from 10 to 30 feet above the tree tops, averaging 15 feet, the lower altitudes giving better results. During the dusting a northwest wind blew diagonally across the lot at an average of 3 miles per hour and the relative humidity rose from 43 to 53 per cent while the temperature dropped from 73° to 65° F. The condition produced by rising humidity and falling temperature decreases the upward movement of air, thus allowing the dust cloud to settle. These satisfactory conditions for dusting caused the greater part of the dust to settle into and through the tree tops covering the foliage well. However, in spite of these conditions it was estimated that about 20 per cent of the poison settled outside of the treated area. In an individual tree the distribution of poison was uniform from the top to the bottom; but observations and poison tests showed that the higher and more level parts of the plot received more poison than the deep depressions. On June 14 three days after dusting, 1.15 inches of rain fell, washing about 75 per cent of the poison from the foliage. Because of this it seemed best to re-dust the plot, which was done on the evening of June 19, when two loads, of 500 pounds each, were applied. This took 65 minutes in the air. Good coverage was secured, as the atmospheric conditions were practically the same as at the time of the first application, except for a change in the direction of the wind, during dusting, when it shifted from northwest to south.

Previous to June 14 there was little or no dew, and the wind reached a maximum of 12 miles per hour. These conditions permitted a maximum loss of poison, for it was found that if the dust became wet upon the foliage as a result of fog or dew and was then allowed to dry, it adhered better than when the foliage was dry between the dusting and first rain. The following table compiled from four plots illustrates this fact.

Inches of rainfall	Per cent poison lost	Condition of foliage, dusting to first rain	Number of rains between dusting and sampling	Plot
0.77	74	dry	1	Sandwich 1
0.77	52	wet	2	Sandwich 2
1.15	75	dry	1	Sandwich 1
1.59[1]	46	wet	5	Barnstable 2
1.75	68	wet	4	Barnstable 3
2.26	87	dry	5	Sandwich 1
2.29	79	wet	6	Sandwich 2

[1]0.24 inch of rain fell before the first sample was taken.

From certain of the observation points in Plot 1, Sandwich, leaf samples were taken and the amount of arsenate of lead determined.

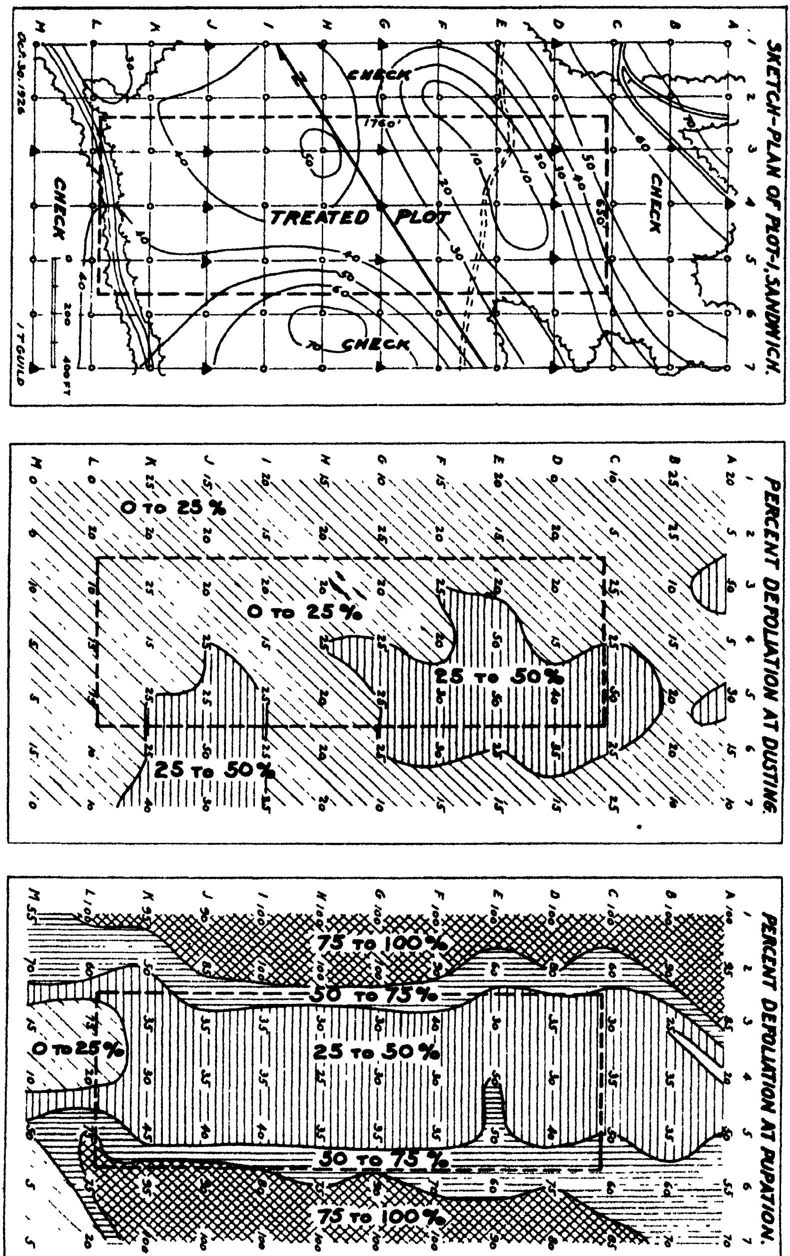

Fig. 10.—Sketch plan and defoliation record for Plot 1 Sandwich, Mass. The sketch plan shows the location of points for observation and collection, the relation of the treated section to the check section, and the topography of the plot. The defoliation diagrams show the percentage of defoliation at each observation point at the times of dusting and pupation. These percentages are grouped, by shading, into four general classes.

Heavy triangles on the sketch plan show the location of these points. These tests showed that the distribution throughout the plot varied and that the first rain removed proportionately more dust than succeeding rains. The following table shows the distribution of the poison in the plot and the loss under the influence of rain.

PLOT 1, SANDWICH. DISTRIBUTION OF ARSENATE OF LEAD IN MILLIGRAMS PER 10 SQUARE INCHES OF LEAF SURFACE BEFORE AND AFTER VARIOUS AMOUNTS OF RAIN, FROM JUNE 11TH TO JULY 15TH

Point	Species	First application		Second application		
		1st test	2nd test	1st test	2nd test	3rd test
TREATED SECTION						
D-3	White oak	1.224	0.250	1.430	0.160	0.088
D-4	Scarlet oak	1.119	0.250	1.440	0.286	0.127
D-5	White oak	0.816	0.157	1.100	0.260	0.203
G-3	Scarlet oak	0.122	0.050	1.070	0.426	0.170
G-4	White oak	0.833	0.333	0.865	0.323	0.159
G-5	White oak	0.741	0.303	0.602	0.171	0.092
J-3	Scarlet oak	2.125	0.500	1.760	0.432	0.197
J-4	Scarlet oak	2.060	0.625	1.270	0.328	0.170
J-5	Scarlet oak	1.500	0.278	1.710	0.472	0.231
Average		1.171	0.305	1.250	0.318	0.160
CHECK SECTION						
A-3	Scarlet oak	—	—	0.240	—	—
A-4	White oak	0.000	0.000	0.800	0.285	trace
D-1	White oak	0.000	0.000	0.200	0.083	trace
D-7	White oak	0.204	trace	0.278	trace	trace
G-1	Scarlet oak	0.000	0.000	—	—	—
G-7	White oak	0.116	trace	—	—	—
J-1	Scarlet oak	0.000	0.000	0.246	trace	trace
J-7	White oak	0.000	0.000	0.328	trace	trace
M-3	Scarlet oak	0.800	0.204	0.652	0.312	trace
M-7	Scarlet oak	0.000	0.000	0.086	0.000	0.000
Average		0.124	0.023	0.354	0.097	0.000
Precipitation		0.00″	1.15″	0.00″	0.77″	2.26″

Note—Check points on each side are 275 feet from treated plot, and those on east and west end are 420 feet and 220 feet respectively.

Observations three days after the first application showed that most of the larvae of the second stage, and many of the third stage, were dead, while the mortality in the larger stages was small. Five days later, at the time of the second treatment, there was about an 85 per cent kill in the plot, which was increased to over 95 per cent before pupation. This treatment increased the kill somewhat within the plot and destroyed many migratory larvae entering the plot from heavily defoliated checks.

The differences between the defoliation of the treated and that of the untreated sections were used as an index of the effectiveness of the treatment. The final observations on defoliation showed a marked decrease from the check toward the center of the plot as indicated in the defoliation diagram and the following table.

	Treated plot	Check plot
Average per cent of defoliation at the time of dusting...	25	18
Average per cent of defoliation at the time of pupation	36	71
Per cent increase....	11	53

These observations show that there was an increase of only 11 per cent in the treated area as against 53 in the check, which indicates a satisfactory result when the severity of the infestation is considered.

Methods and Results

The topography of the areas selected for treatment included both flat and rolling sites characteristic of the Cape Cod region. The sketch plan of Plot 1, Sandwich, suggests the type most common, which has neither the flatness of the plains nor the ruggedness of the mountains. However, the region is subject to high winds and local fogs which seriously hindered operations. The type of tree growth on five of the treated plots was similar, with white, scarlet and black oak predominating, although in two plots there were scattering pitch pines. On the sixth plot the growth was oak sprout. The following table summarizes the characteristics of the areas:

General Characteristics of the Dusted Plots

Plot	Growth		Number acres in		Topography	
	Type	Average height	Treated plot	Check plot	Range in elevation	Character
Barnstable 1	oak & pine	20 ft.	25	35	50 ft.	hillside
Barnstable 2	oak	25 ft.	25	6	30 ft.	level
Barnstable 3	oak sprout	6 ft.	20	9	15 ft.	level
Falmouth 1	oak	35 ft.	25	25	100 ft.	hillside
Sandwich 1	oak	25 ft.	25	41	60 ft.	rolling
Sandwich 2	oak	25 ft.	25	41	75 ft.	hillside

These plots were selected in the spring after a survey of the heavily infested areas on Cape Cod. At that time sample collections of egg clusters were made to obtain records of hatching and egg parasitism. These records are summarized below.

Egg Parasitism and Hatching Records for Dusted Plots

Town	Number of clusters	Number of eggs	Per cent of parasitism	Per cent of non-hatch	Per cent of hatch
Barnstable	20	6250	32.9	29.6	37.5
Falmouth	10	5000	23.5	12.0	64.5
Sandwich	10	3200	24.5	16.2	59.3

These plots, treated and check areas combined, varied in size from 30 to 65 acres. Some uniform and time-saving method was necessary for obtaining data throughout such a large area. This was accomplished by means of the quadrat system, mentioned before, which distributed points of observation at uniform intervals of 200 feet. Observations on the degree of infestation, defoliation and poison distribution, were made at these points, so that a series of notes was established for each, from which the conditions for the whole area were determined.

The degree of infestation was determined by an egg cluster count at each point in an area 10 feet square, or 1/435 of an acre. The individual counts, which varied from 0 to over 300, were averaged. From these averages the average number of egg clusters per acre was figured. The following table shows the character of the infestation.

CHARACTER OF INFESTATION IN DUSTED PLOTS AS INDICATED BY COMPOSITE EGG CLUSTER COUNTS

Plot	Degree of infestation	Number of egg clusters per acre		Number of observation points	
		Check plot	Treated plot	Check plot	Treated plot
Barnstable 1	Heavy	9000	17000	51	27
Barnstable 2	Heavy	20000	17000	6	33
Barnstable 3	Light	no egg cluster count made		5	10
Falmouth 1	Heavy	7000	9000	27	25
Sandwich 1	Heavy	13000	13000	67	24
Sandwich 2	Heavy	no egg cluster count made		8	9

Three dosages of arsenate of lead were used in this work: 30, 40 and 50 pounds per acre. The dosage does not indicate the actual amount deposited upon an acre but means that the pilot was given enough poison to cover the plot at that rate per acre if it were evenly distributed within the confines of the plot. Actually, the plots received less than that amount, as there was more or less driftage of the poison as it fell. The Barnstable 2 plot was treated at the rate of 30 pounds per acre, the Sandwich 2 at the rate of 50 pounds, and all others at the rate of 40 pounds per acre. The Barnstable 2 and Sandwich 1 plots were re-dusted after rain had removed part of the poison.

In each plot the distribution of poison was tested by taking leaf samples from certain points as in the Sandwich 1 plot. At each collection point a tree was selected from which all samples in the series were taken. A sample consisted of six leaves, two taken at the top, two from the center, and two from the bottom of the tree, with a total surface of about 75 square inches. The first set was taken as soon as possible after dusting and other samples were taken at intervals after rain. The quantity of

poison was determined by the Hamilton-Smith[1] colormetric method. The results of these tests indicate that distribution is greatly influenced by topographical and meteorological factors. The rolling Sandwich 1 plot dusted under satisfactory meteorological conditions showed more poison in the tests than the hillside plots with an equal or greater dosage of poison. In certain plots it was found impossible to treat steep hillsides except when the wind movement was toward them. The results on the level plots were not conclusive, as the samples on Barnstable 2 plot were not taken until 0.24 inch of rain had fallen, and mechanical trouble with the hopper caused a serious loss of poison in Barnstable 3. The results of the tests immediately after dusting are summarized in the following table.

AVERAGE DISTRIBUTION OF ARSENATE OF LEAD FOR ALL PLOTS IN MILLIGRAMS PER 10 SQUARE INCHES OF LEAF SURFACE IMMEDIATELY AFTER DUSTING

Plot	Application	Number of pounds per acre	Average number mg. poison per 10 sq. ins.
Barnstable 1	1st	40	0.962
Barnstable 2	2nd	30	0.545[1]
Barnstable 3	1st	40	0.466[2]
Falmouth 1	1st	40	0.719
Sandwich 1	1st	40	1.171
Sandwich 1	2nd	40	1.252
Sandwich 2	1st	50	0.991

[1]0.24 inch of rain fell before the sample was taken.
[2]Considerable loss of poison by poor hopper action.

As the work progressed it became apparent that about 1 milligram of arsenate of lead per 10 square inches of leaf surface was needed for quick killing. The Sandwich 2 plot may be used as an illustration. This hillside plot sloped to the south and to the east. Difficulty was experienced in covering it in a uniform manner. The deposit averaged 0.69 milligrams per 10 square inches of leaf surface at the east end, and 1.49 milligrams at the west end. Throughout the plot the kill was practically complete, but it proceeded more slowly where the poison deposit was light. At the east end the defoliation, therefore, increased from 40 to 90 per cent and from 15 to 30 per cent at the west end, a difference of 50 per cent in the first case as against 15 per cent in the second.

All plots except Barnstable 3 showed more or less defoliation at the time of dusting. Since the larvae must eat enough poisoned foliage to

[1]A Colormetric method for showing the distribution and quantity of lead arsenate upon sprayed and dusted surfaces. Hamilton, C. C., and Smith, C. M. Jour. Econ. Ent., Vol. 18 No. 3, pp. 502–509. 1925

receive a toxic dose, there was an increase in defoliation in all treated plots. This increase was greatest in Barnstable 2 where the lowest dosage was used. It was checked against the increase in the untreated areas as an index of the effectiveness of the treatment. To secure the necessary data a record was made at each observation point in the plots immediately after dusting, giving the average per cent of defoliation for a circle 200 feet in diameter immediately surrounding the point. This procedure practically resulted in a record of defoliation for the total plot, and from these figures the average defoliation was established. A similar set of notes was made at the time of pupation. In every case there was a material increase in the per cent of defoliation in the check over that in the treated section, the difference varying from 9 to 42 per cent, as is shown in the defoliation table. The Falmouth plot showed the least difference; it had serious defoliation, as the larvae had reached the fourth and fifth stage before treatment. The greatest differences were found in the plots that were dusted when the larvae were smaller.

Average Defoliation Conditions for All Plots

Plot	Average percentage of defoliation at time of dusting		Average percentage of defoliation at pupation		Increase in percentage		Increase in percentage check over treated
	Treated plot	Check plot	Treated plot	Check plot	Treated plot	Check plot	
Barnstable 1	26	15	33	33	7	18	11
Barnstable 2	20	23	55	100	35	77	42
Barnstable 3	0	10	10	60	10	50	40
Falmouth 1	43	49	61	76	18	27	9
Sandwich 1	25	18	36	71	11	53	42
Sandwich 2	37	40	50	92	13	52	39

The airplane service for the experiment was supplied by the Curtiss Flying Service, Inc., of Garden City, Long Island, which furnished a Standard J-1 plane, powered by a Curtiss C-6, 180 H. P. motor, and equipped with a pneumatic duster. Mr. John Andrews operated the plane and his hearty cooperation did much to make the experiment a success.

Cost

The total cost for the season for the six different plots, two of which were redusted, varied from a minimum of $15.03 per acre to a maximum of $29.12 per acre. This variation was to be expected from the nature of the experiment, for it was sought to test the method of applying poison to plots of differing character and under a diversity of conditions. To test the effect of the poison different dosages were used, and the

cost of the poison varied accordingly. The distribution of the plots at different distances from the landing field, resulted in a considerable difference in flying cost. The adjustment of mechanical difficulties and the adaptation of method to terrain and meteorological conditions had to be worked out as occasion arose which necessarily consumed time and added to the expense. Furthermore, the redusting done in two of the plots, on account of rain, practically doubled the cost in these cases. The fully equipped plane, with pilot and mechanic, was provided at a fixed price per flying hour; the poison was supplied at a uniform price. The cost of a single application, varied from $12.13 to $24.35 per acre, or the average cost being about $15.50 per acre.

Summary and Conclusion

1. In 1926 satisfactory experiments in the use of airplanes for dusting forest areas were conducted in New England. Six plots were treated, five of which were heavily infested by the gipsy moth. In all cases the treated plots showed much less defoliation than the untreated checks, the greatest differences being found in the case of plots dusted when the larvae were small.

2. The flying conditions in treating forest areas are more difficult than in dusting low-growing crops because the trees are of varying heights. As the pilot is unable always to fly close to the tree tops it is necessary to drift the dust cloud into the trees. To accomplish this the dusting must be done when the wind has a low velocity—5 miles per hour or less—and the air has a high or strongly rising relative humidity. These conditions most frequently occur late in the afternoon.

3. It is difficult to treat hillsides unless the wind movement is toward the slope.

4. About 1 milligram of arsenate of lead per 10 square inches of leaf surface is necessary to kill the gipsy moth larvae quickly under ordinary field conditions. About 40 pounds of poison per acre is necessary to secure this rate of distribution.

5. Airplane dusting is best adapted for the treatment of large forest areas and its results for the season of 1926 encourage the hope that this method can be adapted for insect control in such territory.

Mr. J. S. Houser: I want to ask if Mr. Barnes thinks that this work would be applicable to woodlands in general in New England?

Mr. D. F. Barnes: On account of the cost I think it would be applicable only in special instances. For instance, a lumber company holding large acreage might treat a portion of their timber which was infested by a defoliating insect in order to protect the balance of their holdings.

Adjournment: 4:30 p. m.

REPORT OF THE SUBCOMMITTEE ON INSECTICIDE MACHINERY

In the following report it has been attempted to give material illustrating the trend of thought of workers with insecticide machinery, and suggestive of new activities, rather than the compilation of detailed data. We believe that the list of research projects involving this subject will be of value, and we trust that workers will inform us of new projects as they are undertaken or old projects which may have been omitted, in order that the list may be complete.

Dr. Philip Garman has been especially responsible for the work in the North East; Mr. J. A. Berly, in the Cotton States; Mr. B. B. Fulton in the Middle West; and Professor E. R. deOng in the far West. We are indebted to workers quoted in this report and to many others throughout the country for their response to our requests for information.

1. Location of Research Projects on Insecticide Machinery

Michigan Agricultural Experiment Station. A comparative test of orchard sprayers; large and small outfits under high and low pressures.

Ohio Agricultural Experiment Station. A study of hand sprayers and dusters for truck crops.

Purdue University. A study of spray nozzles to determine proper load for each type. Under direction of Professor O. G. Anderson.

United States Bureau of Entomology. A study of cotton dusting machinery—B. R. Coad. Insecticide machinery in connection with truck crop insect control.—R. E. Campbell. Insect collecting machines—J. E. Dudley.

U. S. Bureau of Entomology and the California State Department of Agriculture, Cooperating. Developing a hot water sterilizer for bulbs. Work conducted by Mr. C. L. Doucette of the Bureau and Messrs. Mackie and Scott of the State Department of Agriculture.

University of California. A cooperative project on the study of stationary spraying plants. Publication being prepared.—W. P. Duruz and B. D. Moses. An investigation of methods for standardizing commerical power sprayers, and on the "economics" of spraying.—E. R. de Ong.

Santa Paula Citrus Fruit Association, Santa Paula, California, Analyses of nicotine dust with Bean self-mixing duster to determine effectiveness.—C. T. Dodds.

2. Self-Mixing Duster

Reports were received from California, Florida, Georgia, Illinois, Maryland, Massachusetts, Michigan, New Jersey, New York (Long Island and Hudson Valley), Ohio, Pennsylvania, Wisconsin. All reports dealt with the Bean machine.

The comment was generally favorable, although there is unanimous opinion that the machine needs improvement. Several workers call attention to the heat generated in the mixing process, which may aid in the incorporation of the nicotine, but may prove dangerous in some cases.

One common difficulty lies in the fact that mi ing is not effective if much more than 50 pounds of material is placed in the hopper at one time. One worker calls attention to the fact that a 4 h. p. engine is not powerful enough to run the machine effectively, and some difficulty was experienced even with an 8 h. p. engine. Considerable difficulty was experienced with the feed. When there was a large amount of dust in the hopper, the flow of dust was too great; when the hopper was less than half full, the flow of dust was insufficient. This is especially troublesome when dust is applied

under a hood or in other places where the discharge can not be closely watched. The cut-off needs improvement.

With regard to materials mixed, Mr. J. E. Dudley, Jr., of the U. S. Bureau of Entomology, stationed at Madison, Wis., wrote as follows: "With two experimental carriers of nicotine and calcium cyanide, it was found impossible to mix them in this machine. One, silversand, a volcanic dust found in unlimited quantities in Utah and used commercially by some concerns, was found to be so heavy and packed so hard that the engine would not turn the mixing paddle. At the other extreme, Celite, an extremely light, filtering compound sold by the Celite Products Company of New York City, could not be mixed for it stayed right on top like a foam, even when 50 per cent lime was used. This Celite weighs approximately 35 pounds to the bushel. These were the two extremes and between these I found that the speed and efficiency of mixing varied somewhat if quite light or quite heavy carriers were used. Apparently the machine was made primarily for calcium hydroxide. Gypsum is a least bit heavy for it while some of the lighter colloidal substances are a little light for it."

Mr. C. T. Dodds, Entomologist of the Santa Paula Citrus Fruit Association, Santa Paula, Calif., writes as follows regarding the uniformity of mixture of dust in the self-mixing machine: "The following tests were made: 50 pounds of dehydrated lime was placed in the hopper and the machine was started; nicotine sulphate was added to make a 2.60% dust. At the end of five minutes four samples were taken from the hopper. They analyzed as follows: center at surface 2.63%, surface at side, 2.81%, center near middle, 2.79%, middle near side 2.74%. This gave an average of 2.69% with the greatest difference 0.18%. The machine was then run half an hour and then the samples were analyzed which were 2.67%. For comparison two drums of ready-mixed dust had samples taken near the surface and from the middle of the drum. The analyses were as follows:

Top	2.76%	2.51%
Center	2.69%	2.71%
Average	2.72%	2.61%
Difference	.07%	.20%

3. Economics of Spraying Operations

There is much interest in the economics of spraying, especially with regards to rapidity of spraying vs. thoroughness and economy of operations. There is a regrettable lack of accurate data in this connection, and the following discussion indicates that a thorough scientific study of the problem might result in great savings for the large orchardists of the country.

Mr. R. S. Woglum, Entomologist for the California Fruit Growers Association, Los Angeles, writes: "We have during the past two years, kept a close observation on the spray work of some forty to seventy-five spray machines, almost exclusively machines of the super-giant type as Hardy, Bean, Friend and Demming.

"It has been our experience that there is no place for a spray machine in the citrus industry except one of these large types which is capable of maintaining a pressure of 350 to 400 pounds when three spray guns are being used. All of these machines are capable of maintaining this pressure. This super-giant machine is the only economic type to be used. At the present time even it is not entirely powerful enough for California citrus spraying. The spray nozzle has no place in the citrus field. The only operator to use a machine with nozzles and perhaps do it economically is a

grower with a very few acres and lots of time on his hands. The economics of citrus spraying is not one of determining how little material one can use on a tree by reducing the size of the aperture or using a mist spray. Labor and time are more important than material.

"Our commercial operations are run largely on the basis of a cent or one and one-fourth cents per gallon for material applied. This practice is so deeply set in California that I am convinced it can not be readily changed. This method is giving the grower satisfaction where spray operators are careful, conscientious men and it, furthermore, is more or less satistactory to the spray operators. Our conditions at present demand the use of twelve to twenty 300 gallon tanks a day in order to cover the acreage that has to be covered and do it within the limited time. Right at the present time the complaint on all sides is that the work is progressing too slowly,—not enough acreage is being covered within the time it should be covered. Mist nozzles would slacken the speed very materially; in fact, a commercial operator using these nozzles would go bankrupt within a very short time in competition with the gun. It is not a question that a spray nozzle can not cover a tree as thoroughly as a spray gun, but the question is that the spray nozzle can not cover a tree as thoroughly and do it within as short a time. There is an overhead of around $15.00 per day for labor exclusive of team hire on a spray rig. The saving of a certain amount of spray material is unable to offset the labor costs under our conditions. There is a natural tendency of growers to invest just as little money as possible in equipment, and the mist nozzle would require far more investment than the spray gun because of the larger number of machines required to cover a certain acreage. There is, furthermore, the difficulty ever present in California of securing an adequate supply of good labor. With the type of labor available our observation has been that poorer coverage is general where mist nozzles have been used than with the gun."

The viewpoint taken above is probably typical of many of the large scale orchardists of the west. That this race for speed and economy by increasing the spray output may be carried too far is suggested by the following from Professor deOng, University of California: "Another point . . is the economics of high discharge rates versus high priced labor. In other words, if we believe our nozzle men are to be paid double what they were five years ago, what effect is that going to have on the discharge rate at which the machine may be operated so as not to lose, by increasing the rate of discharge of spray to compensate for increased cost of labor.

"To cite an example, one outfit I tested was wasting between twenty and forty cents per tree of spray material, and saving one-half cent on the time of the operator."

In eastern fruit sections, where operations are usually not on such a large scale there is much less tendency toward excessive rates of discharge; in fact, there is a swing back in favor of the spray rod in some sections. Even in eastern sections, however, there is a definite problem regarding rapidity vs. effectiveness and economy.

4. Standardization of Spray Machinery

It was practically unanimously agreed in the returns from questionnaires sent out that it would be very desirable to standardize spray equipment as much as possible. Considerable doubt was expressed as to the feasibility of bringing about such standards except by a gradual process of evolution.

So far as we have determined, the only definite attempt at standardization of the operation of spray outfits has been done in California.

Professor E. R. deOng writes as follows: "I am at present carrying on work with

the horticultural officers in southern California in an attempt to gather field data on all phases of the operation of spray machines, that is, power outfits. The horticultural officers are charged with the duty of regulating all of what we term 'commercial' sprayers, or those who are applying spray for a definite charge per acre or per gallon. The question has now arisen as to what points are best for an inspector to observe and pass judgment upon as to whether or not the outfit may be performing satisfactorily both to the grower and the operator.

"The equipment that we are suggesting for the inspector is: (A) A 'T' to attach to the end of the hose, one end of which receives the gun or rod and the other is for testing the pressure gauge and then with all leads running, the readings on the gauge at nozzle and at pump are compared and if more than 25 pounds variation is shown, it is considered that the machine is doing unsatisfactory work. Three things are commonly recognized as causing a drop in pressure: First, the use of pipe or hose of too small a diameter. This can be obviated by using larger sizes, for example, changing from one-half inch to three-quarters. Second, too large an aperture in the disc; this, of course, must be considered with the type of spray desired, whether coarse or fine. Third, pump not giving sufficient pressure. The latter two difficulties can be overcome largely by either running the pump at a higher pressure or using smaller apertures. (B) Pressure gauge as mentioned above, and for this kind of work tested gauges should be used which can be bought from the following companies: American Schaeffer and Budenberg Corporation, Berry and South Fifth Streets, New York City, Foxboro Company, Inc., Foxboro, Massachusetts, Ashcroft Manufacturing Company, 100 East 42nd Street, New York City. (C) A graduated measure of five or ten gallons capacity for determining discharge rate.

"Spray manufacturers with whom I have talked consider that these points properly checked will give a very good idea of the behavior of outfits."

5. Stationary Spray Outfits

The stationary spray outfit has come into use to a larger extent in California than in the eastern fruit sections. Studies that are being conducted on this outfit may show that it has a larger field of application than it has filled heretofore. Professor W. P. Duruz of the University of California writes an interesting discussion of the stationary spray outfit:

"Professor B. D. Moses and myself are working on a cooperative project dealing with an investigation of the stationary spray plant. We have been making numerous trips throughout the State, visiting some ten or more plants that are now in operation and we have run a great many tests while spraying was going on, with the view of determining the efficiency of the plant, pressure drops, power factors, cost of operation and upkeep, and special advantages and disadvantages of the system. The original stationary plant was installed in the Hayward Reed orchard in 1908 and at the present time serves 212 acres of full bearing trees and is still giving satisfactory operation. There are other plants that have been installed since that time and all of the users are uniformly agreed that this system of spraying is economically sound where adverse soil conditions prevent spraying at the critical time, and when at least three sprays a year are necessary. The acreage covered by these plants varies from 19 to 260 and the cost of installation ranges between $35.00 and $57.00 per acre. The cost of spraying, including labor, material, and power, ranges between two and three cents per gallon, depending upon the kind of material and dilution.

"The advantages of stationary spraying systems may be enumerated as follows:

"1. Spraying may be accomplished in spite of adverse soil conditions.

"2. Pests that require quick action are speedily controlled.

"3. Large orchards may be sprayed as effectively as small ones with the same equipment.

"4. There is considerable saving in time and labor. Ninety-five per cent of the time is used in spraying and no time is lost in refilling.

"5. The system is a permanent improvement to the property and there is no great depreciation, at least during the first ten years.

"6. Spraying is possible with minimum danger of knocking or bruising the fruit on low hanging branches.

"7. Props do not interfere with spraying.

"8. Hillside orchards may be more easily sprayed.

"9. Intercropping or permanent cover crops may be employed. Tractors and teams are eliminated.

"10. Great conveniences due to the use of electric power.

"Some of the disadvantages may be stated as follows:

"1. High initial cost. This point, however, is not such a great disadvantage when you consider that the system is in use 15 years and longer.

"2. All responsibility is in one plant. If there is any breakdown all spraying must be stopped. However, this is true of a portable rig also.

"3. Non-portability. Outlying tracts must be sprayed with a portable rig.

"4. Possibility of spray material settling in pipes. This is true particularly where large mains are used and too few hoses used to keep up sufficient velocity to prevent settling. This is overcome by using a brand of arsenate of lead that maintains its suspension, also by using pipes of not too great diameter and operating enough hoses to keep liquid flowing.

"5. Upkeep and attention to numerous parts.

"6. Possible damage to system during cultivation.

"7. Possible corrosion of pipes by spray material. From actual practice, however, this does not seem to be an important objection because we have examined the interior of pipes which have been in use for 15 years or longer and are unable to find any evidence of corrosion.

"8. Possible loss of spray material by leakage. This, too, is a small point and owners do not find this a serious disadvantage.

"9. Some spray material may be wasted during the flushing out of the lines. This objection is also overcome by a careful man who supervises the running of the plant. With a little practice the engineer is able to judge the amount of material needed to spray, and adjust the supply so that clear water is turned into the line just before quitting time and the sprayer knows it is time to stop when clear water reaches the nozzle.

"10. There is some loss in pressure due to friction. This varies from 25 to 50 pounds, but the pumps are easily adjusted to high pressure and on account of the stability of the pump there is greater assurance of maintaining high pressure at the pump.

"11. Demand charge on electric motor is constant. Some growers overcome this by using their motor for other purposes such as cutting silage, sawing wood, etc.

"12. Freezing and breaking of pipe. This is a disadvantage in colder regions where the ground freezes, but is overcome by laying the pipe to an even grade and providing for proper drainage of the lines before winter."

6. New Developments

A new type of sprayer has been developed and is being tested experimentally. This machine has been termed the "liquid duster" because of the fact that it applies a liquid spray or mist in the same manner as dust is ordinarily blown onto the foliage. One such machine, manufactured by the Rex Spray Company, Toledo, Ohio, has been in use in Connecticut during the past season. Regarding it, Dr. Garman writes:

"The machine consists of a duster and sprayer combined, the duster consisting of a high-speed fan similar to that of many dusting outfits. The spray is delivered by a nozzle in the end of a short delivery tube, and the liquid is blown by the force of the air upon the tree. The engine driving this apparatus is a standard Ford engine, at least in the one seen this year, on the outfit. The liquid pump tank and blower do not occupy more space than that occupied by a standard spray outfit.

"Advantages lie in the rapidity of application, which is about the same as a dusting machine, except for time required to fill the tank. It is also much easier to apply liquid by this means than by the usual gun or rod.

"Disadvantages apparent (judging from the opinion of grower using it) lie in difficulty in reaching high trees in windy weather. There are also some mechanical difficulties, one of which appears to be the high speed fan, which, unless extremely well made, is likely to give trouble.

"However, the machine seems to be a promising invention and deserves the attention of horticulturists, entomologists, and fruit growers generally. Whether it will prove practical can only be learned by trial, but from present appearances it seems to be good."

In Wisconsin Mr. J. E. Dudley, of the U. S. Bureau of Entomology, has made such radical improvements in a collecting machine which he terms the "aphidozer," that even this old, familiar apparatus may truly be termed a new development. Mr. Dudley writes as follows:

"The aphidozer was designed and developed at the Madison, Wisconsin field station of the Federal Bureau of Entomology in an effort to solve the Pea Aphis Project after other remedies had apparently failed in this section. The machine consists of a hopper 7 ft. long by 2 ft. high by 17 in. wide, suspended from a special framework mounted on two wheels. At the forward opening of the hopper is a reel consisting of seven specially made brushes for brushing and knocking the insects from the plants into the hopper. A special feature of the machine is a series of four transverse iron rods just to the rear of the lower forward edge of the hopper. These have a quadruple function: 1. To sift the insects, thus allowing them to fall through from the plant; 2. To retain them by preventing the plants from again pulling them out of the hopper; 3. To provide a surface over which plants may lie at an obtuse angle while they are being brushed and knocked; and 4. A means for helping to clear the under side of foliage of its insects.

"Although designed primarily against the pea aphis, the machine was soon found to work on other crops with less injury to the crop than to peas. It is now being used in addition to peas, in an experimental way entirely, against miscellaneous insects on alfalfa, against the alfalfa weevil, and against miscellaneous insects on potatoes.

"I feel that it is too early to say anything definite as to the effectiveness of this machine. It appears to be effective against three insects on three different crops, but its effectiveness may be lessened by seasonal conditions affecting both the insects and the crops as the experiments are continued.

"The advantages of the machine are:

"1. The cheapness of application, requiring only the time of a man and one horse to treat fields.

"2. The fact that it can be used in any kind of weather except during rain.

"3. The rapidity with which acreages can be swept, the only stops necessary being to empty the hopper when it contains a bushel or more of insects.

"4. The fact that it requires little skill to use it properly when compared with means of applying insecticides.

"5. Perhaps as important as any, the psychological effect upon the user when unbelievable numbers of insects are actually caught and brought to his attention.

"The disadvantages are:

"1. In that the plants are actually hit in being swept, there is an opportunity for damage, particularly to crops like peas when it is not used at the right time or when the speed of the reel is increased above the safety point.

"2. The fact painfully brought out last summer, that many users expect to find it a panacea and use it without any common sense at all, with the resulting damage to the crops.

"3. The greatest disadvantage at present is the fact that we are not exactly sure of what its effectiveness will be under the conditions of the average season.

"In short, this machine has decided possibilities on certain crops, has already shown considerable effectiveness in increasing yield during the conditions of one season, but showed no increase in yield another season. Although simple to operate, yet it must be used with intelligence, and is still decidedly in the experimental stage."

F. H. LATHROP
PHILIP GARMAN
B. B. FULTON
R. H. SMITH
Committee

REPORT ON OIL EMULSIONS

Dec. 27, 1926.

TO THE COMMITTEE ON POLICY:

Your sub-committee, appointed to summarize and so far as possible standardize oil sprays, begs leave to offer its third annual report as follows:

Questionnaires were again used, this being the only method available to obtain the needed facts. These were sent to entomologists and others in the various states and provinces of the United States and Canada. Replies with data were received from the following, listed alphabetically: A. J. Ackerman, U. S. D. A., Arkansas; J. L. Baskin, Tennessee; California State Department of Agriculture; E. L. Chambers, Wisconsin; Leroy Childs, Oregon; J. J. Davis, Indiana; E. R. de Ong, California; L. L. English, Illinois; B. B. Fulton, Iowa; S. B. Fracker, Wisconsin; Arthur Gibson, Canada Dept. Agr.; T. L. Guyton, Pennsylvania; W. S. Hough, Virginia; R. W. Leiby, North Carolina; G. M. List, Colorado; Z. P. Metcalf, North Carolina; D. C. Mote, Oregon; E. J. Newcomer, U. S. D. A., Washington; New Jersey Agric. Expt. Station; J. R. Parker, Montana; P. J. Parrott, New York; R. H. Pettit, Michigan; B. A. Porter, U. S. D. A., Indiana; H. J. Quayle, California; C. H. Richardson, U. S. D. A.; R. H. Robinson, Oregon,; W. A. Ross, Canada Dept. Agr., Ontario; W. J. Schoene, Virginia; O. I. Snapp, U. S. D. A., Georgia; E. P. Venables, Canada

Dept. Agric., B. C.; R. S. Woglum, California Fruit Growers Exchange; M. A. Yothers, U. S. D. A., Washington; W. W. Yothers, U. S. D. A., Florida.

The excellent cooperation on the part of so many men in different parts of America has enabled us to give conclusions of value and this aid is very greatly appreciated by the committee.

The information gleaned from the answers submitted is summarized as follows:

I. Effect on Insects

1. In areas where the San Jose scale is a pest, the growers continue to use dormant oil sprays and are getting satisfactory results. No changes in recommendations are warranted although the answers show a greater tendency to use 3 per cent strength where oil emulsion is used as the control and seems to be more consistently effective than where 2 per cent oil is used.

2. Reports on the oyster shell scale show the usual variation in results with dormant sprays. In a few cases lime-sulphur gave better results than oil sprays. Fairly good control obtained with both commercial oil sprays and lubricating oil emulsion. In a few cases 3 per cent is said to give good control but in the majority of cases an 8 or 10 per cent oil content was found necessary to secure satisfactory kill. After careful consideration of all answers it would appear that consistent spraying every year with a 3 per cent oil will prevent oyster shell from increasing and that an 8 or 10 per cent spray will give fairly complete control with one thorough application. Dormant oil sprays are satisfactory for the control of the scurfy scale, a 3 per cent oil usually being sufficient.

3. The oil sprays are evidently proving increasingly useful as dormant sprays for insect control. Pettit reports good control of *Physokermes abietis* and *Chermes abietus* with 1–20 commercial and 2 per cent lubricating oil emulsion, when applied shortly before new growth starts in spring. Z. P. Metcalf secured effective control of gloomy and Euonymus scales. Fracker and Chambers report effective control of *Gossyparia spuria* on elm. Snapp found a 3 per cent emulsion would destroy *Lecanium quercifex* and *Ceroplastes cirripediformis*. A 3 per cent emulsion seems generally effective against the adult pear psylla if used just before egg-laying. Not very effective against eggs although one experimenter observed that young psyllids hatching from eggs sprayed with oil spray failed to develop. The oil also seems to be effective against nymphs.

The common red spider and the European red mite are effectively destroyed with 3 and 4 per cent emulsions. Spring applications seem to be preferable.

Ross found 3 per cent emulsion, applied when buds are on point of bursting, as good a control for black cherry aphis as nicotine. Also that 4 per cent emulsion with 2–4–40 Bordeaux before buds swell controls peach leaf curl and cottony peach scale. The brown apricot scale on prunes and apricot is satisfactorily controlled with a 2 per cent concentration of any of the lighter lubricating oils. A 2 to 3 per cent emulsion gives good control of cottony maple scale according to Davis. M. A. Yothers reports on tests against the eggs of three species of treehoppers (*Ceresa bubalus*, *C. basalis* and *Stictocephala inermis*) which insert their eggs in the bark leaving only the outer tips more or less exposed. Early spring dormant applications of 2 per cent lubricating oil emulsion plus ½ per cent cresylic acid gave a 74 per cent kill while the same treatment about six days before eggs began to hatch killed 89 per cent of the eggs. The recommendations for leaf-roller control varies from 4 to 8 per cent oil. In a comprehensive statement read before the last summer meeting of Northwestern

Horticulturists, Plant Pathologists and Entomologists at Tacoma, Parker reviewed the work and recommendations being made by various states for leaf-roller control. He concludes that effective control is obtainable with a 4 per cent spreader emulsion or with an 8 per cent emulsion without spreader. Parker also reports effective control of blister mite with 4 to 8 per cent emulsion. Hawley's experiments (Utah Station Bulletin 197) do not agree with these conclusions. Pettit reports 97 to 100 per cent kill of apple aphids in a series of tests with different commercial oils and oil emulsions when applied as a delayed dormant spray.

4. This question called for a number of answers, all bearing on the efficiency of summer oil sprays for the control of the codling moth. It was generally agreed that a 2 per cent emulsion or oil spray would kill codling moth eggs or those eggs laid on the oil-sprayed surface soon after spraying. The oils seem to have little or no hindering effect on oviposition since the moths seem to lay as freely on oil-sprayed surfaces as elsewhere. The oil covering seems to have little effect on the young larvae unless the spray was recently applied, but answers to this question were quite variable. In some cases the residual effect of the oil lasted over several days to a week but usually only a day or two. Hough made a series of experiments thoroughly spraying individual apples with a commercial oil spray recommended for codling moth control. Twenty-four hours later newly hatched larvae were allowed to crawl on the apples. Twenty per cent died on the apples, some before and some after making a "sting." Thirty-four per cent of the larvae were successful in entering the oil-covered fruits. No answer indicated that codling moth control could be accomplished with oil sprays where arsenicals were omitted even in part. Every one seemed to agree that we do not have data to warrant recommending oils in place of arsenicals and some were very emphatic that oils could not be substituted for arsenicals. Experiments indicated that combinations of oils and arsenicals are better than arsenicals alone. However, a serious difficulty arises when this combination is used or where oils follow arsenical sprays as was brought out especially in statements by E. J. Newcomer. Such combinations make it difficult if not impossible to remove the spray residue, an increasingly important problem.

In answer to the question, "Effect of substitution of oil sprays for arsenicals on abundance of and injury by other chewing insects", Porter states that red-banded leaf-roller was worse in blocks sprayed only with oil than in those sprayed with an arsenical. Flint found *Metachroma interruptum* causing considerable damage to apples where oil alone was used although satisfactorily controlled where arsenate of lead was used.

5. This question called for information on the effectiveness of summer oil sprays for orchard insects. Spring applications of 2 and 3 per cent emulsions gave control of San Jose scale equal to dormant sprays but summer applications were less effective although giving sufficient control to make it useful in cases of severe infestation or infestations likely to cause spotting of fruit. Exposed aphids or leaf-hopper nymphs fairly well controlled with 2 per cent emulsion, the degree of control being quite variable. Apparently not as efficient a protection as nicotine sprays, although in some cases as high as 96 per cent kill of aphids was obtained with a 3 per cent emulsion. In general the 2 per cent emulsion gave complete control of oyster shell scale when applied shortly after hatching. Essig reports good control of mealy bugs, mites, soft scales, young scales and aphids under California conditions, with 2 per cent emulsion. *Pseudococcus* spp. on many plants and *Tetranychus* sp. and *Paratetranychus* sp. on fruit trees are mentioned specifically. *Lecanium corni* on deciduous

trees was controlled with 2 to 4 per cent emulsion. Summer attacks of red spider on deciduous trees are commonly checked with summer sprays of oil emulsion (?2 per cent) according to de Ong, the species concerned including *Tetranychus* spp., *Bryobia praetiosa* and *Paratetranychus pilosus*. Mote, Robinson and Childs in Oregon found 1½ to 3 per cent emulsions effective against two-spotted mites on strawberry, pear, hops and cherry, the strength used apparently dependent on the plant being treated. Faurot's experiments in Missouri, as reported by Haseman, indicate that the summer applications of 1 to 2 per cent oil emulsion have proven quite effective in the control of the grape leafhopper.

6. Summer applications of oil sprays are generally effective controls for many citrus insects. In general we refer to summer spraying as applications made when trees are in foliage. In the case of citrus trees the term summer spraying may be misleading since these trees are evergreen. We may, however, recognize a difference between summer and winter spray applications in the case of citrus plants for it is known that such trees are more liable to oil spray injury during the warmer summer months.

In Florida the oil sprays are generally effective against scale and white fly. According to de Ong the white lubricating oils are being used very extensively in citrus districts of Southern California, especially in the regions where the scale is said to be resistant to fumigation and the most successful procedure at present is spraying with oil, followed within 10 days by fumigation. Essig reports good control of *Coccus hesperidum*, *C. pseudomagnolarium* and *Saissetia oleae* with 2 to 4 per cent emulsion.

7. But few reported results of experiments against insects attacking greenhouse and ornamental plants. There is, however, apparently a good field for work and experiments to date indicate a much greater use of oil sprays for this class of plants than in the past. Essig and de Ong report good control of mealy bugs on ornamentals, Essig mentioning specifically a 2 per cent emulsion as being effective. Parrott found a 2 per cent homemade or commercial white oil emulsion effective against white pine scale and further reports that experiments to date give promise of a more general usefulness of the oil sprays against such pests on evergreens.

It should be borne in mind, however, that the degree of tolerance varies for different species of conifers and some oils are more injurious than others. Moreover the application of oils to such species as Canadian blue spruce destroys, for a considerable period of time, the natural coloration, which is an objectionable feature.

II. Effect on Plants

At present, one of the most important factors limiting the use of oils in the summer time is, according to Porter, "a lack of fundamental knowledge as to its exact effect on plant tissue, the conditions under which injury is most likely to occur, and how much margin of safety there is, if any."

Newcomer writes, "I believe the plant physiologist should be interested in work on oil sprays, particularly those used during the growing season." As our problems become more detailed and intricate we must look to workers in specialized fields for assistance and cooperation. In the case of injury to plants by oil sprays, which involves so many factors, the assistance of the plant physiologist, would no doubt be a great help, for while the entomologist can detect most of the injuries, a plant physiologist would know better what to look for, how to measure injury and could diagnose the injury with greater efficiency. We must know the reasons for insecticide injury

to eliminate the trouble and it is hoped that workers may find it possible to enlist the cooperation of their colleagues in plant physiology.

8a. Dormant applications of oil sprays are generally recognized as safe. No injury reported where properly used. In one case severe damage followed when peach trees were sprayed during a snow storm. It is generally recognized that injury by oil sprays applied during the dormant period is most likely where temperatures are below freezing at the time of spraying. As would be expected citrus trees are more subject to injury in winter than are deciduous trees.

8b. No damage to apple by 2 to 4 per cent emulsions after buds had swollen but several reported some injury with certain commercial oils when used during the delayed dormant period. Delayed dormant sprays are not generally safe for peach.

8c. Harmful effects of summer applications. Spraying of peach trees with any of the oils is generally recognized as unsafe.

Every report indicated some injury to apple by summer applications. These were usually of minor importance and consisted of burning of leaves although in some cases the damage amounted to a considerable commercial loss. In some instances the same observer reports all types of injury from a slight burning of foliage to a discoloring and cracking of the fruit, with no apparent explanation. In general, a 2 per cent emulsion gave no injury or so slight as to be negligible, excepting when applied during very hot weather (90° F. or above). A more general injury results from a 3 per cent emulsion. Some of the commercial oils give a more or less consistent burning, oftentimes severe.

Temperature and humidity are doubtless important factors. According to Quayle, harmful effects to citrus plants from the use of heavy lubricating oils include inhibition of blossoming and fruit sets, effect on the rind of the fruit and effect on shipping and keeping qualities. These types of injury occur in southern California near the coast but do not occur to any extent 50 miles away from the coast. This injury induced by the heavy lubricating oils is due, according to Quayle, to the retention of the oil on the foliage and fruit and consequently the injury is more marked in the cooler and moister sections along the coast and during the winter period rather than in the interior drier sections or during the long summer months. Essig and deOng report that trees suffering from drought are more subject to injury. Woglum says, "weather plays a very important part in oil injury, particularly very hot weather with low humidity."

From the variety of answers received to this question it is very evident that a careful study of all factors influencing injury by oil sprays is much needed.

9. Effect of summer oil sprays on foliage, size, color, and finish of fruits, time of ripening, chemical and physiological changes in fruits, keeping quality, etc.

The answers received to this question again emphasize the need of further study in cooperation with plant physiologists of the exact factors which cause or prevent injury.

The use of a 1 or 2 per cent emulsion on deciduous fruits, excepting peach, under normal favorable conditions, seems to be safe with little or no harmful effects to the foliage, fruit or tree. Dormant applications of 7 or 8 per cent of certain commercial oils resulted in killing or retarding the development of apple buds according to Parrott. English reports retardation of opening of leaf buds of apple by excessive strengths of delayed dormant applications, this being especially true with Grimes varieties. Several referred to the different degrees of susceptibility to injury by different varieties of apple. Porter reports serious injury to the finish of the fruit,

especially if the application is made close to harvest time. He notes that in such cases the skin is dull and lifeless, giving the apple an unattractive appearance. In addition, oil-sprayed apples collect a great deal of dust if the orchard is dusty or near a dusty highway and such dust is very difficult to remove. Childs reports that growth may be checked and fruit fail to properly color.

Evidently the citrus fruits are more subject to the effects of oil sprays than are deciduous fruits. W. W. Yothers reports that the excessive use of oil will prevent the foliage from attaining its natural size and in the case of oranges the skin will remain green longer than where no oil is used. Woglum notes the following harmful effects from the use of oil sprays: retarded coloration of fruit, reduction of blossoming and fruit set, drop of immature fruit, burn of fruit, increase of aphis and mealy bug following heavy oil emulsions, increase of dead wood, influence on the quality of fruit and perhaps on the keeping quality. Quayle finds that in sections near the coast certain oils stimulate the younger growth. On the other hand the older leaves are oftentimes dropped. If applied within a month, or two or three months before harvesting, it delays coloring and also interferes with artificial coloring of fruit.

10. Some of the commercial miscible oils cannot be used on deciduous foliage of any kind with any degree of safety. The emulsions seem safe for apple, pear, plum, prune, raspberry, grape, cherry and citrus. It is not safe to spray the foliage of peach and elm. White oils are apparently safer than the ordinary lubricating oils.

11 and 12.* The limiting factors in the use of summer oil sprays include high temperature and humidity, difficulty of coverage of branches, cost of the white oils, and our lack of information regarding the exact factors which cause injury. In combination with or following the use of arsenate of lead it causes the lead to adhere too firmly, offering difficulties as a result of excessive adhering residues. Oil-sprayed fruit was highly polished and where oil and lead were used in combination the residues were less conspicuous according to Flint.

Present information will not permit general recommendations for the use of summer oil sprays. They are however, highly useful for more or less specific situations and apparently will find greater usefulness in the future.

III. Chemical and Other Problems

13. Of those answering the question relative to the oil emulsion formula found most satisfactory and most generally used by growers, eight indicated the boiled oil emulsion with soap as the emulsifier, five the caseinate-oil emulsion, and one the Bordeaux-oil formula. In several cases two or more formulae were indicated without preference. In a number of instances, especially those reporting from the west coast, there is a more general use of the commercial oils. The general tendency seems to be to purchase the spray ready prepared, whether an emulsion or a miscible oil, rather than to use home-mixed, except in the case of some of the larger growers.

14. Are the physical and chemical properties of oils as now determined a true index to the selection of suitable oils for different insecticide purposes?

It seems to be generally agreed that viscosity, volatility and specific gravity are a partial index but not a true or complete index. W. W. Yothers says, "Our experiments with different oils having the same chemical and physical properties have given very contradictory results." The sulfonation value and oxidation are factors which may prove of value. The first three qualities seem to offer fairly reliable criteria to determine the insecticide value. The percentage of unsaturated hydrocarbons present or the sulphonation test seems to indicate the likelihood of injury to

plant tissue. Frank A. Herman, chemist of the Central Experimental Farms at Ottawa, Canada, in a letter to Arthur Gibson, writes as follows: "The physical and chemical properties of oils as now determined, bear a certain relationship to one another, when considering specific gravity or density, boiling range, flash-point, fire-point, capillarity and viscosity. Either determination taken alone, for instance, drawing conclusions from the use of an oil of a certain specific gravity, is valueless, for it is quite feasible to mix light and heavy oils thereby obtaining oils of any desired specific gravity. But a low gravity reading combined with a low flash-point and boiling range will give some indication of the volatile constituents of the oil; in a measure indicating the penetrating power of the oil and subsequent injury to foliage."

15. Some report little difference between the so-called red and white oils and a few indicate greater toxicity for the white oils. The majority however consider the red oils slightly more toxic to insects and more harmful to plant tissue than the white oils. The white oils are prohibitive in many cases, however, because of cost. Emulsions prepared with the two types of oils appear to be equally stable.

16. There is a great variety of opinion relative to the merits of different emulsifiers. The soap emulsifiers with heat apparently give a more stable emulsion but on the other hand soap emulsions are more affected by waters upon dilution than are the cold mixed emulsions with Bordeaux, casein, etc. An excess of emulsifier in the cold mixed emulsions may reduce the efficiency. Parker reports a better control of leaf-roller with caseinate-oil emulsion than with soap-oil emulsion.

17. Some report no harmful effect when oil sprays follow a sulphur spray. In the majority of cases, however, severe burning results and recommendations should call attention to this fact.

18 and 19. The adhesiveness of arsenate of lead is greatly increased when applied with an oil spray or when followed by an oil spray. According to Newcomer "Analyses show that practically none of the lead can be removed by ordinary wiping" where oil follows lead sprays and he sends a photograph to illustrate. This is the general observation of most experimentalists and is very important in view of the recommendations calling upon growers to remove excessive amounts of spray residues.

There is some indication that arsenate of lead in combination with oil emulsion causes dropping of fruit and foliage.

20. There is a general belief, based on experimental evidence, that a combination Bordeaux-oil emulsion spray is slightly less efficient as an insecticide than oil alone but that there is no difference in the fungicidal efficiency of the Bordeaux. Porter's experiments indicate that full strength Bordeaux with oil materially reduces the efficiency of the oil when used as a summer spray.

Parrott found the 2 per cent oil emulsion with Bordeaux applied as a delayed dormant, followed by the usual schedule, was just as effective against apple scab as lime-sulphur. Other observers report the combination as effective against peach leaf curl.

Respectfully Submitted,

J. J. DAVIS, *Chairman*
W. W. YOTHERS
A. J. ACKERMAN
L. HASEMAN

Committee

Scientific Notes

The Cotton Worm in Michigan. At the Corn Borer Station, maintained by the U. S. Bureau of Entomology and the Michigan State College at Monroe, Michigan, various truck, garden and field crops were grown the past season. Among these crops was cotton. This grew to over two feet in height, bloomed, fruited some of the bolls, almost reaching maturity. On or about September 15 it was observed that the foliage of these plants was badly damaged by the cotton worms. All stages of the larvae were found including several cocoons. Adults were also noticed flying about. It would seem that migrant moths arrived at Monroe during the latter part of August.

Damage to grapes and peaches was reported from various points in southern Michigan.

This is probably the first time that this insect has completed a generation in Michigan.

PHILIP LUGINBILL, *U. S. Bureau of Entomology, Monroe, Michigan.*

Archytas cirphis—AN EXPLANATION AND CORRECTION

The October 1926 issue of the JOURNAL contains a paper by O. H. Swezey on "Recent Introductions of Beneficial Insects in Hawaii." On account of the distance, author's corrections of galley proof did not reach the editor in time to be incorporated before going to press. Thus a desirable footnote to *Archytas cirphis* Curran, on page 718 was omitted. This footnote was to call attention that the writer had received the name from Mr. Curran but that so far as was known the description had not been published. By recent letter from Mr. Curran it is now known that it will yet be a few months before the description is published. As printed on page 718, and also on page 715, the name *cirphis* is incorrectly spelled.

Another misspelled word occurs on page 716, line 28, where "*Prosopus*" should be "*Prosopis*." Further, the line at bottom of page 715 should read: Proc. Haw. Ent. Soc., Vol. V, No. 2, p. 299, 1923. The reference as printed is incomplete.

O. H. S.

Injury to Sweet Potato by *Systena taeniata* var. *blanda* Larva. From observations made during the fall of 1926, it is evident that the larva of *Systena taeniata* var. *blanda* is responsible for a certain type of injury to sweet potatoes in some sections of North and South Carolina. For several years small pin-like holes, and some larger, have been noted in sweet potatoes at the time of harvest. Thorough inspection of the stored crop has not given any indication of the agency responsible for the damage. During September examinations were made of sweet potatoes in the fields at Pantego, N. C., and the larvae of *Systena taeniata* var. *blanda* which reached the adult stage about the middle of October, were found feeding on the potatoes. These field inspections showed that in most cases the larvae fed intermittingly, spending the rest periods in the soil adjacent to the potatoes. This manner of feeding resulted in attack on a new area of potato at each feeding period, which accounts for the volume of surface injury. When the potatoes were disturbed, any larvae in the act of feeding quickly dropped to the ground. The damage consisted for the most part of pin-like holes in the epidermis, with some extending down into the potato to a depth of $\frac{1}{16}$ inch or more. The stem end of the potato was subjected to greater attack than other portions but in some instances the whole potato was injured. The principal

damage occurred during September and early October, the first adults emerging about the second week in the latter month. The damage seemed to be more severe than elsewhere on dark muck lands where sweet potatoes had followed a crop of spring white potatoes. While this type of injury had been observed for several years, it had received little attention from the growers, since it did not affect the food value of the potato or reduce the yield. When the growers began to market their potatoes through cooperative associations, however, a rigid inspection was required and this injury was brought very forcibly to their attention. At Pantego, N. C., when the 1925 crop was marketed, several growers had as much as 10 per cent of their crop discarded because of injury by this flea beetle.

W. A. THOMAS, *Bureau of Entomology.*

Damage to Potato by *Pycnoscelus surinamensis.* During June, 1925 while conducting an anopheline survey in southern Haiti, the French priest at La Valle, a village situated at an altitude of 2400 feet near the city of Jacmel, showed me specimens of a species of roach which was inflicting severe damage upon the tubers of his potato crop. Since material was abundant a number were brought alive to Port au Prince Approximately 40% of these were parasitized by a sarcophagid determined by Dr. Aldrich as *Sarcophaga sternodontis.* Mr. Caudell identified the roach as *Pycnoscelus surinamensis.* Records indicate that heretofore this form has confined its depredations chiefly to roses. WM. A. HOFFMAN

Names of Apple Leaf Hoppers. The writer has recently acquired by exchange with Dr. D. M. DeLong specimens of his *Empoa (Typhlocyba) malini* described in the JOURNAL OF ECONOMIC ENTOMOLOGY for June 1926 (Vol. 19, No. 3, pp. 469–470). Examination of the internal genitalia of these reveals that the species is the same as the *Typhlocyba xanthippe* described by me in the Proceedings of the U. S. National Museum, Vol. 68, Art. 18, p. 14. Dr. E. P. Felt, editor, has kindly informed me that the issue of the JOURNAL OF ECONOMIC ENTOMOLOGY referred to was published June 15, while my paper was issued June 10, thus having priority. It is possible as pointed out in connection with my description that the species has been named in Europe, although I have not yet been able to verify this surmise.

In the revision of the American *Typhlocyba* I named *T. pomaria,* which evidently is primarily an apple insect, being reported from that plant in Pennsylvania, Virginia, Illinois, Arkansas, and Colorado. It is known to occur also in Nova Scotia, Massachusetts, Maryland, Ontario, Iowa, and Kansas. *Typhlocyba xanthippe* McAtee (*malini* De Long) is known from Massachusetts, New York, and Ohio. *T. rosae* Linnaeus, which in the past has generally been assumed to include all apple-feeding *Typhlocyba,* while primarily a rose feeder, actually breeds on apple also. It appears to occur throughout all but the southeastern states. Various species of *Erythroneura* may be found temporarily on apple but apparently only *E. hartii* Gillette, breeds on this plant. It is known to occur from Connecticut and Virginia to Illinois and Arkansas.

While upon the subject of names of the apple leaf hoppers and congeners I will advert to Mr. E. P. Van Duzee's note in the *Pan-Pacific Entomologist* for July 1926 (pp. 45–46). Mr. Van Duzee here discusses the question of priority of publication as between *Eupteryx,* Curtis and *Typhlocyba,* Germar. This question is chiefly an academic one as the genera named are distinct on the basis of validly selected genotypes. Nothing depends upon their relative priority except the name of the

supergeneric group—tribe, sub-family, or whatever it may be ranked,—and that only under the system followed by the writer and various others, of basing such names on the oldest included genus, a system Mr. Van Duzee does not use.

The synonymizing of *Eupteryx* and *Typhlocyba* as done by Mr. Van Duzee in his Catalogue (1917, p. 707) is quite another matter, and is strictly unlawful under the generally accepted rules of nomenclature. Curtis designated the type (*picta* Fabricius) of his genus when he described it in 1833, and Woodworth in 1889 remarking that all the species originally included in *Typhlocyba* except *quercus* Fabricius belong to *Eupteryx* in its most restricted sense designated that species as the type.[1] Having validly selected and actually generically distinct type species, the two genera can be synonymized by no legal nomenclatorial process. The name *Empoa*, Fitch used by Van Duzee for the apple leaf hoppers is virtually a *nomen nudum* as its type species *E. querci* Fitch is unidentifiable because the original description of that species applies as well to one as another of several species, and the type specimen is lost.

W. L. McATEE

FERNALD ENTOMOLOGICAL CLUB

Massachusetts Agricultural College entomologists attending the Fifth Philadelphia Meeting of the American Association for the Advancement of Science assembled for dinner on New Year's Eve in the Hotel Normandie, Philadelphia. The speaker of the evening was Dr. H. T. Fernald. On the proposal of Dr. W. A. Hooker the old Fernald Entomological Club was reorganized, with Dr. W. E. Hinds as president and Perez Simmons as secretary. The object of the club is the promotion of co-operation and acquaintanceship among the many entomologists who have studied under the guidance of Professor C. H. Fernald and Dr. H. T. Fernald. There are no dues, and all entomologists who have worked under the Fernalds constitute the membership.

Those present at Philadelphia numbered 32, as follows: Dr. H. T. Fernald, Amherst, Mass.; A. J. Ackerman, Bentonville, Ark.; Dr. H. W. Allen, Riverton, N. J.; D. F. Barnes, Melrose Highlands, Mass.; A. I. Bourne, Amherest, Mass.; S. W. Bromley, New York City; A. F. Burgess, Melrose Highlands, Mass.; R. L. Coffin, Riverton, N. J.; S. M. Dohanian, Melrose Highlands, Mass.; C. F. Doucette, Santa Cruz, Calif.; Dr. E. P. Felt, Albany, N. Y.; R. B. Friend, New Haven, Conn.; G. J. Haeussler, Riverton, N. J.; Dr. W. E. Hinds, Baton Rouge, La.; H. E. Hodgkiss, State College, Pa.; Dr. W. A. Hooker, Washington, D. C.; J. A. Hyslop, Washington, D. C.; B. R. Leach, Riverton, N. J.; G. F. MacLeod, State College, Pa.; L. S. McLaine, Ottawa, Canada; G. B. Merrill, Gainesville, Fla.; Dr. A. W. Morrill, Los Angeles, Calif.; C. M. Packard, W. Lafayette, Ind.; L. H. Patch, Sandusky, O.; H. B. Peirson, Augusta, Maine; Dr. B. A. Porter, Vincennes, Ind.; Dr. W. S. Regan, Yakima, Wash.; E. A. Richmond, Riverton, N. J.; Perez Simmons, Silver Spring, Md.; C. W. Stockwell, Riverton, N. J.; R. D. Whitmarsh, Wooster, O.; and H. N. Worthley, State College, Pa.

[1]Psyche 5, 1899, p. 211. For a full discussion of these matters matters see Proc. Biol. Soc. Wash., 31, 1918, pp. 111-113.

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The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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The Philadelphia gathering will be remembered as one of the large meetings which dealt with matters of pressing importance. The two large and intensely interesting conferences on the European corn borer and arsenical residues demonstrate the possibilities of general conferences, even at meetings with crowded programs. The major interest is bound to dominate and incidentally a side light is thrown on the possibilities of two sections meeting at the same time. We must recognize the passing of the time when all subjects can be covered within a reasonable period in a single series of meetings. It is doubtful if the time of presentation of papers can be limited more than at present unless it is decided to submit all as mimeographed abstracts, grouped as to subjects and discussed under a common head. This would permit presentation of papers and allow discussion of those of sufficient general interest to warrant such treatment. The special paper, while informative and valuable, is better appreciated, as to details at least, when printed and usually can be discussed advantageously by relatively few. The work of the committee on the program is not made easier by the rather usual alternation of large and small meetings, since the varied conditions in the two make difficult the application of an uniform policy.

The necessity of controlling insects and yet marketing fruit above suspicion so far as human health is concerned, shows the narrow limits within which the entomologist must work and may develop into systematic, professional control of spray operations. Extreme injury by codling moth in a New Jersey area was followed by the organization of a group of fruit growers who, working under close, expert supervision, cleared up a severe infestation and obtained an excellent crop

of marketable fruit. Dr. Headlee is to be congratulated upon his venture into a relatively new phase of economic entomology. It was a real contribution to applied entomology.

Those who attended the instrumental insemination of the honeybee by Dr. Watson were privileged to witness a wonderfully delicate operation, a perfection in technique which is worthy of the highest admiration. It is a noteworthy venture into a hitherto baffiing field and a method which may come to mean much to the beekeepers of the world. A section in which such a demonstration can be staged is a credit to any scientific organization.

Reviews

The Insects of Australia and New Zealand by R. J. TILLYARD, pages i–xvi, 1–560, 44 plates (eight colored), numerous text illustrations. Angus and Robertson, Ltd., Sydney, Australia, 1926.

This is more than an ordinary text book. It is a comprehensive, taxonomic survey of the 45,000 species of insects occurring in a most interesting section of the world for the zoologist or entomologist,—the land of the marsupials, the home of the duckbill and other strange forms. Entomologists of the northern hemisphere will recognize large numbers of the genera and species discussed in the volume and will find many suggestive of entirely different times, a fauna harking back to the days when the world was relatively somewhat younger. The student of distribution will discover much suggestive in this work and its comparisons with the world fauna and that of Australia and the much more restricted one of New Zealand. The numerous citations afford ready access to many sources of original information in regard to these and other topics.

The author has made a special and highly commendable effort to systematize the enormous amount of data assembled in a relatively small compass. Twenty-four orders are recognized and superfamilies used where they can be employed advantageously in bringing generally related forms in one group. There is also a uniform nomenclature of wing veins and comparisons with other generally used systems. The discussion of the fossil insects of the antipodes is an admirable and somewhat unusual feature in a text book. There are illuminating numerical comparisons of the faunae of Australia and New Zealand for the various groups as well as for the class as a whole.

The bulk of the work is taken with the systematic accounts of orders and families, the former being separated by a general tabular statement and the latter by data in the more usual key form, there being in each group a statement in relation to its economic importance. Much of this matter is in small type, presumably to provide maximum information in a minimum of pages. There is a chapter on the collection and preservation of insects, a glossary and an extended index. The illustrations are mostly excellent and an important part of the volume.

A book such as this is the work of years with a background of extensive experience. The author has enjoyed exceptional advantages in both regards and has prepared a

noteworthy contribution destined to hold an important place in current literature. It is the text book of Australia, a storehouse of information for the naturalist and a work which should be available to all general entomologists and naturalists throughout the world. Quarantine officials at important ports in both hemispheres should have a copy of this book at hand. Both author and publishers are to be congratulated upon this addition to general scientific literature.

E. P. FELT

Current Notes

Professor Arthur I. Bourne of Amherst, Mass., addressed the Connecticut Pomological Society at Hartford, December 16.

Mr. George Lewis, British coleopterist, who visited China, Japan, Ceylon, and Algiers, died September 5, aged 87 years.

Professor C. P. Gillette, Director of the Colorado Agricultural Experiment Station, visited the division of insects, U. S National Museum, November 18.

The public address of the Entomological Society of America was given on Tuesday evening, December 28, by Dr. G. H. F. Nuttall on "Insect Parasites of Man."

According to *Science*, Professor Carlos E. Porter has been elected president of the new Chilean Society of Natural History recently organized at Santiago, Chile.

Messrs. George A Dean, Manhattan, Kansas, W. P. Flint, Urbana, Ill , J. J. Davis, Lafayette, Ind., and J. S. Houser, Wooster, Ohio, visited Washington, D. C., after the Philadelphia meetings.

The following recent appointments have been made in the Bureau of Entomology: C. H. Griffith, Junior Entomologist, Twin Falls, Idaho; Donald S. La Croix, Junior Entomologist, corn borer work, Sandusky, Ohio.

Dr. Alvah Peterson, of the United States Bureau of Entomology, visited the laboratory at Vineland, Ontario, on October 19, in connection with the Oriental peach moth situation.

Mr. R. M. White, Junior Entomologist, Entomological Branch, completed his appointment on November 15 and intends to take further postgraduate work in entomology at the University of Minnesota.

Dr. Edith M. Patch, Orono, Maine, visited Washington, D. C., after the Philadelphia meetings, and on returning home about the middle of January, she stopped at Riverton, N. J., and New Haven, Conn.

Mr. C. H. Alden, Assistant Entomologist at the Peach Insect Laboratory of the Bureau of Entomology, Fort Valley, Ga., for more than five years, has resigned to enter commercial work.

Dr. Ralph L. Parker of the Kansas Agricultural College, has been promoted to Associate Professor of Entomology, instead of "Assistant Professor" as was announced in the December issue of this JOURNAL.

The twelfth annual meeting of the Pacific Slope Branch, American Association of Economic Entomologists, will be held in conjunction with the meetings of the Pacific Division, A. A. A. S., at the University of Nevada, Reno, Nevada, June 22 to 25, 1927.

Mr. R. D. Bird, Seasonal Junior Entomologist, Entomological Branch, who resigned on September 15, has proceeded to the University of Illinois, where he is employed as an assistant in the Department of Zoology.

A new Japanese beetle quarantine office was recently opened at 42 West First Street, Mount Vernon, N. Y. This office supervises matters relating to the recent extension of the regulated area in New York and Connecticut.

In connection with a trip to New York on annual leave, Dr. William Schaus took occasion to examine the types of Lepidoptera described by Henry Edwards which are housed in the American Museum of Natural History.

Dr. William M. Mann, formerly of the Bureau of Entomology and now Director of the National Zoological Park, was married October 30, 1926, to Miss Lucile H. Quarry, formerly Assistant Editor in the Editorial Office of the Bureau.

Recent announcements have been made of the deaths of the following entomologists: Fernand Meunier, member of the Entomological Society of France; Rev. F. D. Morice, Hymenopterist, England; Tasushi Nawa, Japan; Professor E. Giglio-Tos, University of Turin, Italy.

Dr. L. O. Howard, Chief of the Bureau of Entomology, has been elected an honorary member of the Czechoslovak Academy of Agriculture, for eminence in science as applied to agriculture. The Academy confers honorary membership on only 20 foreigners.

At the meeting of the Nova Scotia Fruit Growers' Association, held early in December, Mr. Arthur Kelsall presented two papers, one entitled "Recent Experiments in the Control of Budmoths," and the other, "Miscellaneous Notes on Some Insects and Insecticides."

Mr. H. C. Fall of Tyngsboro, Mass., arrived in Washington October 22 and spent several days there, studying the types of the Staphylinid genera *Hymenorus* and *Euaesthetus* in the Casey and the Hubbard and Schwarz collections at the U. S. National Museum.

Prof. H. T. Fernald of the Massachusetts Agricultural College has been granted leave of absence from Christmas, 1926, to May, 1927. During this period his address will be 137 East Concord Ave., Orlando, Florida.

Importations of European corn borer parasites for this winter are well under way. More than 45,000 cocoons of *Microgaster tibialis* Nees have been collected in northern France, and some 84,000 borers are on hand from which four species of parasites may be reared.

According to *Science*, a program of radio talks has been arranged by the Boston Society of Natural History, to be given on alternate Wednesdays at 7.30 P. M. from WBZ. The talk for January 12 is by C. W. Johnson on "Some Common Insects of the Household."

Dr. W. H. Brittain, formerly provincial entomologist of Nova Scotia, who has recently returned from a trip around the world as a representative of the American Cyanamid Company, has been appointed Professor of Entomology at MacDonald College, succeeding Professor W. H. Lochhead, resigned.

Mrs. Annie Trumbull Slosson, for nearly 35 years a member of the New York Entomological Society, a collector of insects and author of many articles about insects, and of books and essays on other subjects, died at her home in New York City, October 4, 1926, aged 88 years.

The following officers of the Entomological Society of America were elected at the Philadelphia meeting: President, F. E. Lutz, American Museum of Natural History, New York; First Vice-President, W. E. Hinds, Louisiana State University, Baton Rouge, La.; Second Vice-President, E. P. Van Duzee, University of California, Berkeley, Calif.; Secretary-Treasurer, J. J. Davis, Purdue University, Lafayette, Ind.

Dr. H. Prell, Professor of Forest Entomology at the School of Forestry, Tharandt, Saxony, recently made a visit to the United States and Canada and gave particular attention to the work being done on forest insects in the Bureau of Entomology and the Entomological Branch. He also visited a number of museums and field stations.

Resignations in the Entomological Branch, Canadian Department of Agriculture, have been announced as follows: R. B. McCormack, Fredericton, N. B.; R. D. Bird, Treesbank, Man.; Messrs. R. M. White, E. McMillan and J. E. Revell have completed the periods of their temporary appointments. The temporary appointments of G. H. Hammond, A. A. Wood, Stewart Walley, N. J. Atkinson and W. G. Mathers have been extended.

Mr. Curtis G. Lloyd, founder of the Lloyd Library, Cincinnati, Ohio, died November 11, aged 68. The Lloyd Library contains more than 52,000 volumes and is composed chiefly of works on botany, mycology and materia medica, though including many publications on insects. The series of bulletins issued by the Library contains 27 numbers, of which five are entomological.

Prof. J. J. Davis, of Purdue University, has recently forwarded to the U. S. National Museum the type of *Agrilus paramasculinus* Champlain and Knull. In sending this type, Professor Davis says in part: "Since I believe that the National Museum is the logical place for types, I am sending this specimen to be deposited in the National Collection."

Mr. Arthur Gibson, Dominion Entomologist, attended the International Corn Borer Organization meetings held at Washington, D. C., on November 17 and 18. While in Washington, Mr. Gibson took the opportunity of visiting the various divisions of the Bureau of Entomology, where he was able to discuss many problems of international interest, and to promote further cooperative work between the two services.

Transfers in the Bureau of Entomology have been announced as follows: H. E. Wallace, Miscellaneous Insect Investigations, to Cotton Flea Hopper; R. W. Moreland, G. L. Smith and G. L. Garrison, Tallulah, La. to Tucson, Ariz.; W. A. Baker, Dallas, Texas, to Arlington, Mass.; R. A. Blanchard, Webster Groves, Mo., to Monroe, Mich.; E. W. Davis, Toppenish, Wash., to Twin Falls, Idaho; L. W. Brannon, Birmingham, Ala., temporarily to Federal Horticultural Board.

The Division of Insects, U. S. National Museum, has recently received a valuable lot of Porto Rican Coleoptera from George N. Wolcott. The lot included cotypes of five species described by Dr. Guy Marshall of the British Museum. In transmitting this material, Mr. Wolcott expressed the belief that the types of species should be placed in the National Collection, where they will be available to a large number of workers.

Professor Addison E. Verrill, Professor Emeritus of Zoology in Yale University, died at Santa Barbara, California, December 10, aged 87 years. Professor Verrill was a student and assistant of Agassiz and was actively connected with Yale University for 46 years. He was an authority on deep-sea fauna, and for several years carried on scientific studies in the Bermuda Islands, from which he described many species of insects.

On October 21 a large delegation of farmers, county agricultural advisers, and officials of the Michigan State College, inspected the corn-borer work in progress at the Monroe, Michigan, laboratory of the Bureau of Entomology. Special groups from various counties in the State visited the laboratory in September and October. Dr. Luginbill, in charge, has given a number of lectures on the corn borer to high schools in southeastern Michigan and to the Lenawee County Grange.

Mr. Carl Heinrich of the U. S. National Museum left on Thanksgiving Day for Boston where he will work in the Gipsy Moth Laboratory at Melrose Highlands, Mass., classifying and naming the Lepidoptera which have been reared there. Species which cannot be identified without the use of the collections will be taken to the Museum for more detailed study. Mr. Heinrich will also stop in New York City to examine types in the American Museum of Natural History.

Mr. W. A. Ross of the Vineland Laboratory, Entomological Branch, sailed from New York on December 4 for Scotland, on the S. S. *Cedric*, to spend the Christmas season with his people at Edinburgh. On November 26, Mr. Ross held a conference at Vineland with the General Manager and three other officials of the Canadian Canners, to discuss the Oriental peach moth situation in the Niagara district and to arrange for certain measures to retard the spread of this destructive insect.

Mr. C. R. Cleveland has resigned from the Purdue Agricultural Experiment Station, Department of Entomology, to accept the position of Entomologist for the Standard Oil Co. of Indiana, with headquarters at 910 S. Michigan Ave., Chicago, Illinois. He is to develop the field of use for oil sprays of various kinds, direct the introduction of such sprays in the field and supervise investigations looking toward the development of new oil spray products and the uses of such materials.

On October 29, Mr. R. A. St. George of the Bureau of Entomology visited the firm of Carl Stossel & Sons, located at Front Royal, Va., to bring to a close an experiment relative to the submergence of hickory, oak, and ash wood in water, to prevent subsequent attack by *Lyctus* powder-post beetles. By following practices recommended by this Bureau, this firm, which makes mallets, mauls, etc., has in the past three years been able to reduce insect injury caused to green and seasoned stock from its former magnitude of 15 to 90 per cent to only 1 or 2 per cent.

Resignations in the Bureau of Entomology have recently been announced as follows: W. E. Dove, Insects affecting live stock, to pursue graduate studies at Johns Hopkins University; C. H. Alden, peach insects, to enter commercial work;

T. E. Bronson, O. E. Gahm, L. W. Orr and Gerald Horton to continue their studies; F. H. Worsinger, Japanese beetle quarantine, to take charge of a nursery at Holmesburg, Pa. The temporary appointments of M. W. Stone, I. W. Berryhill, V. E. Romney, Roy Melvin and E. R. Bynum have been terminated. Wallace Colman, Columbus, Ohio, Bean Beetle Laboratory, has been granted leave without pay to complete his requirements for the doctorate at the Ohio State University.

According to *Science*, through the interest of Senator James W. Wadsworth, Jr., and the cooperation of Colonel B. D. Foulois, Commanding Officer, Mitchell Field, State Entomologist Dr. E. P. Felt of the New York State Museum has arranged for systematic collection over Long Island and adjacent territory at various altitudes, with a specially devised insect trap attached to the wing of an airplane. Preliminary work has resulted in capturing two specimens at an altitude of three thousand feet, and it is expected that considerable numbers will be found even higher in the air. It is hoped that this investigation may develop facts of importance in controlling pests and explain insect movements in different sections of the world.

Mr. J. C. Evenden, Forest Insect Investigations, Bureau of Entomology, reports that in the past season control operations were instituted against an epidemic of *Dendroctonus monticolae* in the lodgepole pine stand of the Bitterroot and Beaverhead National Forests. This outbreak, which began some four or five years ago, has at the present time reached a tremendous magnitude; on the East Fork of the Bitterroot River hundreds of thousands of lodgepole pine and yellow pine trees are killed each year. Within the past two or three years the insects have crossed the Continental Divide from this area and established themselves in the Beaverhead National Forest, where the infestation, unless checked by artificial control, promises to become as serious as that on the Bitterroot Forest, where entire lodgepole pine forests are being destroyed.

The U. S. National Museum has recently received a very extensive collection of water beetles belonging to the families Dytiscidae and Haliplidae from John D. Sherman, Jr. This collection contains approximately 20,000 specimens and represents about 400 North American species and about 200 additional exotic species. It includes a few of the types of species described by H. C. Fall and a large number of cotypes and paratypes of species described by this worker. In depositing the collection in the National Museum, Mr. Sherman states that it is given to the Museum in loving appreciation and honor of Dr. E. A. Schwarz, who has done so much to encourage his collecting and to assist him in work on Coleoptera. This collection is in many ways the counterpart of both the Roberts collection of these beetles in the American Museum of Natural History and of the Blanchard collection in the Museum of Comparative Zoology, so that all three institutions now have fairly complete collections of the North American species of these beetles.

Correspondents of Dr. T. E. Snyder of the Bureau of Entomology report that the city of Honolulu, Hawaii, has just adopted a revised building code, laying particular stress on suggestions that will prevent damage to buildings by termites. In Honolulu termites annually inflict on buildings damage amounting to about a million dollars. There is every reason to believe that the entire west coast of the United States will adopt a similarly revised building code. In New Orleans, La., 80 per cent of the frame buildings are infested with termites, and it is believed that a revised code will be adopted there. In Pasadena, Calif., 50 per cent of the business buildings are

infested, some of them being in a dangerous condition. Other localities of the Southwest, Central West, and Southeast are similarly affected, and our goal is to have standard codes for these sections of the country. The city of Washington has a large number of buildings which are severely infested, some of them being badly damaged. It is now believed that a modified building code is the most economical and practical method of preventing such damage.

Horticultural Inspection Notes

Mr. George T. French, State Entomologist of Virginia, was recently appointed collaborator of the Federal Horticultural Board.

Mr. Lee A. Strong, Assistant Director of Agriculture of California, was in Washington for a few days early in November to confer with members of the Department of Agriculture on matters pertaining to quarantine work, and on other subjects.

Mr. O. K. Courtney, who has been employed as an inspector by the Federal Horticultural Board since December 1, 1918, recently sent in his resignation, effective December 31, 1926. Mr. Courtney is leaving the service of the Department of Agriculture to go into commercial work.

The Christmas tree quarantine in southern Quebec, along the international border, has been continued this year, Mr. A. K. Gibson being in charge of the work from October to December 13. Approximately 35,000 bundles of Christmas trees, representing a total value of $18,000 to the farmers of the quarantined area, have been exported to the United States under certification.

The State Crop Pest Commission of Virginia has been abolished, and the duties of the commission have been transferred to the Commissioner of Agriculture and Immigration with headquarters at Richmond, Va. This office is under the direction of the State Board of Agriculture. Mr. George T. French has been appointed State Entomologist and Mr. C. R. Willey, Assistant Entomologist.

A meeting of the Section of Plant Quarantine and Inspection was held in Logan Hall of the University of Pennsylvania, Tuesday morning, December 27, in connection with the meeting of the American Association for the Advancement of Science. The meeting was well attended by entomologists and pathologists from all parts of the country. The chairman of the section, Mr. Lee A. Strong, of California, was unable to be present, and Mr. C. H. Hadley was asked to take charge of the meeting.

A meeting was held December 16, 1926, at El Paso, Texas, to discuss the Thurberia weevil and pink bollworm situations. There were present at the meetings Messrs. H. L. Kent, Lee A. Strong, Oscar C. Bartlett, R. E. McDonald and Hull from the states, and George Becker and F. S. Puckett from the Federal Horticultural Board. A new development in the pink bollworm situation has resulted from the finding of this insect at rather widely scattered points in the counties of Cochise and Graham in Arizona. The cotton plants in this section of the state are mostly small, and are located in small irrigated districts which should be rather easily cleaned up judging by the success met with in the eradication of the insect from several points in southeastern Texas and southwestern Louisiana. Thirty inspectors are at work to determine the limits of these infestations.

Notes on Medical Entomology

A new department of medical entomology has been added to the research division of the South African Institute for Medical Research at Johannesburg.

According to *Science*, a painting of Dr. Walter Reed has been unveiled at the George Washington University Medical School. Dr. Reed, at the time of his work in connection with the conquering of yellow fever, was a member of the faculty of the George Washington University Medical School.

Dr. R. C. Roark, of the Bureau of Chemistry, returned to Texas about the middle of October to continue cooperative investigations of the chemotropic responses of the screw-worm fly and related insects. The major part of his time while in Texas was spent at the Uvalde laboratory, working with D. C. Parman.

Dr. W. E. Dove, who has been connected with the Bureau's work on insects affecting live stock and was recently assigned to work in Florida, pursuing studies of creeping eruption of man, resigned from the Bureau on October 13 to take up graduate studies at Johns Hopkins University. At the second annual meeting of the American Society of Parasitologists, Dr. Dove and G. F. White of the Bureau of Entomology presented a report on the work they have been doing with creeping eruption, a skin disease of man which is prevalent in Florida and other parts of the South. As a result of experimental work carried out during the summer and fall of 1926, these investigators, working in Florida, proved that the dogs of that section are infested with two species of hook-worms, *Ancylostoma braziliense* and *A. caninum*, and that one of the larval stages of each of these species is capable of invading the skin of man; also that the lesions produced experimentally are very similar to those occurring in natural infestations. Thus it appears that the mystery of this skin affliction, which for many years has been considered due to fly larvae, has been cleared up.

Apicultural Notes

Mr. Jas. I. Hambleton, of the Bee Culture Laboratory of the Bureau of Entomology, during the latter part of January attended beekeepers' meetings in Virginia and Arkansas, as well as the annual meeting of the American Honey Producers' League at New Orleans.

Mr. E. L. Sechrist, of the Bee Culture Laboratory of the Bureau of Entomology, spent a couple of days recently in New York City for the purpose of instructing the Inspection Service, of the Bureau of Agricultural Economics, of that city, in the use of the new honey grading regulations.

Mr. E. L. Sechrist, of the Bee Culture Laboratory of the Bureau of Entomology, spoke before the meeting of the Maryland State Beekeepers' Association on January 5th. He was also on the program of the Beekeepers' Short Course given at Cornell University during the latter part of January.

During the month of December, A. P. Sturtevant, in charge of the Intermountain Bee Culture Field Station, attended the following beekeepers' meetings: Thermopolis,

Wyoming; Billings, Montana; Bozeman, Montana; Boise, Idaho; Salt Lake City, Utah; Grand Junction, Colorado; and Fort Collins, Colorado. Mr. J. E. Eckert, who is also connected with the Intermountain Bee Culture Field Station, attende several of the foregoing meetings.

Recent visitors at the Bee Culture Laboratory of the Bureau of Entomology included Dr. H. Prell, of Germany; Mr. F. B. Meacham, Instructor in Beekeeping at the North Carolina State College of Agriculture; Mr. E. R. Root and Mr. H. H. Root of Medina, Ohio; Mr. A. A. Granovsky, Assistant Entomologist, University of Wisconsin, Madison, Wisconsin; and Miss C. Lucas, of England, who is taking graduate work at Johns Hopkins University.

Pacific Slope Notes

At a meeting of Orange County, California, pepper growers, called to discuss the very serious damage by the pepper weevil, talks were given by J. C. Elmore and R. E. Campbell, of the Alhambra, Calif., laboratory of the Bureau of Entomology.

At the Los Angeles County Truck Crop Growers Institute, held on October 25 and 26, R. E. Campbell discussed truck-crop pests and their control. On October 27, before the Imperial County Truck Growers Association, he talked on lettuce insects, cantaloupe insects, and the pea aphis.

Mr. E. J. Newcomer, in charge of the Yakima, Wash., station of the Bureau of Entomology, states that the codling moth parasite, *Ascogaster carpocapsae*, introduced at Yakima in 1920, continues to thrive and increase. Collections of codling moth larvae from banded trees near Yakima in 1926 yielded 3,800 larvae, of which 855, or about 22.5 per cent, were parasitized. This percentage is higher than has been found before. More than 500 parasitized larvae have been sent to E. P. Venables, Dominion Entomologist at Vernon, B. C., to establish the parasite in the apple-growing regions of British Columbia.

THE ENTOMOLOGICAL SOCIETY OF PENNSYLVANIA

The fourth annual meeting of the Entomological Society of Pennsylvania was held January 18th at Harrisburg, Pa., in conjunction with the State farm products show. Twenty-three entomologists were present from Pennsylvania representing members of the Bureau of Plant Industry, the Federal Bureau of Entomology and the Pennsylvania State College.

The afternoon was devoted to a discussion of the Oriental Fruit Moth problem emphasizing points that needed further investigation and pointing out progress that had been made during the past year. No definite method of control was suggested although recent investigations favor cultivation and the regular P. D. B. treatment. A report of this meeting will be published in the Proceedings of the Horticultural Society of Pennsylvania for 1927.

In the evening the society adjourned for lunch which was followed by an informal gathering and a few short talks. Moving pictures of the Corn borer and the Japanese beetle were shown through the courtesy of the U. S. Bureau of Entomology. Officers for the ensuing year were elected: President, S. W. Frost; Secretary, C. C. Hill.

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Proceedings of the Thirty-Ninth Annual Meeting of the American Association of Economic Entomologists (*Cont.*)

Friday Morning Session, December 31, 9:45

PRESIDENT ARTHUR GIBSON: The first paper on the program this morning is by W. S. Regan.

RELATIVE VALUE OF DIFFERENT INSECTICIDE TREATMENTS FOR THE CONTROL OF CODLING MOTH IN THE PACIFIC NORTHWEST

By W. S. REGAN, *Research Department, California Spray-Chemical Co., Yakima, Washington*

ABSTRACT

There is much difference of opinion on the part of both investigators and practical orchardists as to the most effective and economical control for codling moth, *Carpocapsa pomonella* Linn. The best dosage of Arsenate of lead to use, the advantage of spreader, the value or necessity of a calyx spray, the advisability of dependence on spray dates, the use of oil spray as an ovicide, the factor of thoroughness and the effect of various spray treatments on the removal of spray residue by wiping etc., are all matters over which there is a wide diversity of opinion. The results of numerous tests and observations are given as further evidence in favor or against the matters at issue.

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MR. W. P. FLINT: One matter that came up in connection with some of our work with oil sprays in Illinois might be of interest in some other sections. In spraying a block of mature Ben Davis trees with oil throughout the season, except that the regular lead calyx spray was given, we had forty-two per cent worms on the oil sprayed block against about sixteen on the arsenate of lead sprayed block, but the point that I wanted to bring out was the oil sprayed block had 45.9 per cent of the apples injured by a little beetle, *Metachroma interruptum* Lec., that was

reported at the Cincinnati meeting, and which gouged the surface of the fruit much the same way as the Japanese beetle does, only it is a smaller insect. That was a totally unexpected type of injury that occurred.

MR. P. J. PARROTT: I would like to ask Mr. Regan if he could briefly tell us the results of any experiment with the codling moth where the oil alone was used, and what would be the number of applications to get efficient control?

MR. W. S. REGAN: In the Northwest this season there were a number of growers who for their own information carried out a State oil program. I know a number of growers who used it on apples. Several growers used it on pears. I can give you one case where a grower sprayed three times with one and a half per cent of the oil of Ortho-K. He sprayed four times with lead, and four times with the lead and oil combined on different blocks in the same orchard. Where he used the oil alone, with three applications, he had eight per cent culls due to worms. Where he had used the arsenate of lead alone, he had six per cent with four applications. Where he used the arsenate of lead and oil combined, he had two per cent.

Most of these growers who used the oil alone seemed to think that they had pretty fair results. On pears that worked out very satisfactorily. There were none of the unfavorable reactions on pears that we found on some varieties of apples. I would say that five applications would be the limit needed under our conditions.

PRESIDENT ARTHUR GIBSON: The next is a paper by C. R. Cutright.

PARADICHLOROBENZENE AGAINST THE BLACK PEACH APHIS, *ANURAPHIS PERSICAE-NIGER* SMITH

By C. R. CUTRIGHT, *Ohio Agricultural Experiment Station, Wooster, O.*

ABSTRACT

The results of four years field experimentation show that Paradichlorobenzene can be used safely and effectively.

The chief commercial peach growing section in Ohio is located along Lake Erie about fifty miles east of Toledo. In this section much of the land has been in peach orchards for from thirty to forty years continuously. On lands such as these, and particularly on sandy, gravelly, or stony areas, great difficulty is now experienced in successfully starting a new orchard. Several years ago attention was drawn to this condition by growers who claimed that the death of the newly planted trees was due to the black peach aphis attacking the roots. In this section of Ohio an aerial colony of this aphid is rarely seen.

The insect is subterranean in habitat and is zealously cared for by an ant, *Lasius umbratus*, subsp. *mixus*, var., *aphidicola* Walsh. Upon examination it was found that the roots of most of the dying trees were infested with aphids in more or less numbers. Since this was the case it was only logical to suppose that they were at least a factor in the death of the trees and experiments looking forward to their control were arranged.

During the summers of 1923-24 a large number of insecticides and repellents were applied about the roots of newly set peach trees. The materials used, the amounts, the method and time of application have been reported in Ohio Bulletin No. 387. Of all these materials Paradichlorobenzene, applied as for the peach tree borer, alone gave definite results.

The condition that we presumed was caused by the aphids became apparent each season about the middle of June. It consisted in the

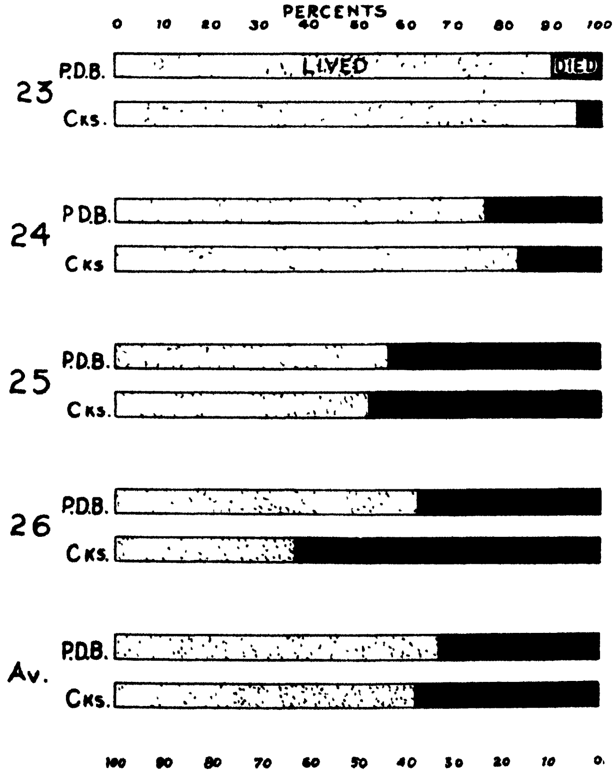

Fig. 11—Survival of peach trees treated with paradichlorobenzene as compared with untreated trees.

cessation of growth, the wilting and withering of the leaves, and finally in the death of the tree. It was considered that the logical time to apply a preventative treatment would be just before or at the first appearance of the signs of injury. However the treatment of trees with Paradichlorobenzene for the control of the peach tree borer is practically never made at this season of the year nor is it applied to trees so soon after planting. Aside from the results to be obtained in aphid control the effect that the material might have on the trees was of much interest and data was collected on this point during a four-year period (Fig. 11). In 1923 thirty trees were treated with Paradichlorobenzene in amounts ranging from 1/6 to 1/2 ounce per tree. Three of these trees or ten per cent died or were very weak at the end of the growing season. Twenty untreated trees were used as checks and one of these or five per cent died. In 1924 fifty-five trees were treated, using from 1/4 to 3/4 ounce. Of these, thirteen trees or twenty-four per cent died. There were seventy check trees, of which twelve or seventeen per cent died. In this year it was noticed that there was a somewhat higher per cent of mortality among the trees treated with 1/2 to 3/4 ounces of the material. In 1925 there were 105 treated trees. Of these, forty-six or forty-four per cent died. We had forty-nine check trees and twenty-three of these or forty-seven per cent died. In 1926 there were thirty-one treated trees, of which twelve or thirty-eight per cent died. On thirty-eight check trees, twenty-four or sixty-three per cent did not live through the season. From the totals of the four-year period 33.4% of the treated trees died, while 38.2% of the check trees succumbed. Since the date of our earliest planting in 1923 I have failed to see in following years any difference in growth between the treated and the check trees. There is little to indicate that Paradichlorobenzene in 1/4 or 1/3 ounce doses injures the tree when applied under the conditions of these experiments. It is of interest to note that the seasons of 1923–24 were favorable to tree growth, with much rain in June and July. In 1925-26 little rain fell during this important period.

As to the effect of Paradichlorobenzene on the aphids, the results can be briefly summarized as follows: Of all the trees treated with this material that have been examined only one has been found that was infested, and it very lightly. Many of the check trees were infested by aphids in considerable numbers. The Paradichlorobenzene as applied in these experiments seemed to act quite definitely as a repellent against the ants. When applied directly against the aphids on trees that were known to be heavily infested, large numbers of the lice were killed.

Considering the foregoing results which were obtained over a four-year period of time and in which about 500 trees were involved, we may safely conclude that Paradichlorobenzene is a safe and effective remedy for the black peach aphis.

However, there yet remains another phase of this problem to be discussed; namely, in spite of the control of the aphids the newly set trees continue to die. During the first year of work we began to doubt if the aphis was really the cause of the trouble and since that time a definite conclusion of this nature has been reached. The following observations led to this belief. Each year many dying trees were examined on which no aphids could be found, or the aphids were so few in number as to preclude the idea of their being the cause of the injury. Young trees were also planted on other types of soil that had not previously grown peaches and were artificially infested to a much greater degree than anything found in the experimental plots. In spite of this severe infestation these trees grew normally. Therefore, the death of the newly set trees is not due to the black peach aphis but is caused by some other agency. This is undoubtedly outside the field of economic entomology and its determination and solution must be attempted by specialists in other lines of work.

PRESIDENT ARTHUR GIBSON: The next paper is by J. R. Eyer.

TESTS OF SOME RECENTLY DEVELOPED INSECTICIDES IN CONTROL OF THE GRAPE LEAFHOPPER AND ORIENTAL FRUIT MOTH

By J. R. EYER, *North East, Pa.*

ABSTRACT

Certain of the more recently developed insecticides including emulsions of pyrethrum, derris, coconut fatty acids, orthotoluidine, wormseed oil, and carbon disulphide were tested in comparison with nicotine sulfate and sodium fluosilicate, colloidal arsenate of lead, and coated arsenate of lead in comparison with dry arsenate of lead. Early in the season the emulsions, and sodium fluosilicate were sprayed on the nymphs and on foliage containing eggs of the grape leafhopper (*Typhlocyba comes* Say). Pyrethrum soap emulsion killed the nymphs equally as well as nicotine sulfate and prevented the hatching of eggs. Derrisol also killed the nymphs but was not so effective as an ovicide. Sodium fluosilicate killed the nymphs but burned grape foliage unless combined with hydrated lime or Bordeaux mixture. Combinations of these materials with Bordeaux mixture did not seem to affect their toxicity to leafhopper nymphs.

Later in the season twigs containing larvae of the oriental fruit moth (*Laspeyresia molesta* Busck), were sprayed with the emulsions mentioned and although no killing

resulted it was observed that the younger larvae which left twigs sprayed with pyrethrum soap emulsion were stunned and unable to re-enter. Further tests with this material were made in the laboratory using sprayed peaches and larvae of graded sizes. When combined with sodium fluosilicate and Bordeaux mixture this insecticide was very effective in preventing larvae from entering the fruit. A dust of pyrethrum powder, hydrated lime, and sodium fluosilicate was also quite effective and sodium fluosilicate combined with hydrated lime and used as a spray or dust killed a large percentage of the larvae.

In field tests sodium fluosilicate-lime dust, and pyrethrum soap emulsion with Bordeaux mixture were superior to arsenicals and nicotine in reducing the percentage of wormy fruit.

During the past several years certain promising insecticides have been developed by entomological workers in the control of the Japanese beetle, the Mexican bean beetle, et al. These have been of several types: (1) emulsions of toxic organic materials, e. g., pyrethrum and ortho-toluidine which kill by contract; (2) improved forms of arsenical stomach poisons, e. g., coated (oleate) and colloidal arsenates of lead; and (3) fluorine compounds which may act both by contact and as stomach poisons, e. g. sodium fluosilicate and sodium fluoride. Since many of these have proven successful in controlling the insects mentioned it seemed advisable to test their toxicity on two species which are particularly injurious in northwestern Pennsylvania, i. e., the grape leaf-hopper (*Typhlocyba comes* Say.), and the oriental fruit moth (*Laspeyresia molesta* Busck.). Workers in the past have shown that the grape leaf-hopper is susceptible to several contact insecticides in the nymph stages and that its eggs are killed by nicotine sulfate. The oriental fruit moth has been shown to be susceptible to nicotine in the egg stage, but the larvae are not readily killed by the ordinary forms of arsenicals. In view of these facts the various emulsions were tested in comparison with nicotine sulfate on nymphs and eggs of the grape leaf-hopper, and the more promising were then tried in control of the oriental fruit moth, The fluorine compounds, of which only sodium fluosilicate was tested. were tried on both insects and the arsenicals were used solely in the oriental fruit moth experiments.

Grape Leaf-Hopper Experiments

The grape leaf-hopper experiments consisted of several phases: (1) laboratory tests to ascertain the relative toxicity of the various compounds on the leaf-hopper nymphs; (2) field-cage tests where the effect of the materials was observed with reference to the eggs and nymphal instars; and (3) field spraying of infested vines to ascertain the control obtainable when the materials were applied on a commercial scale. All

of the compounds tested were used alone and in combination with Bordeaux mixture 8–8–100 which is the standard fungicide employed in grape spray programs. Parallel tests using nicotine sulfate (40%), Bordeaux mixture, and unsprayed material were included for comparison.

Table No. 1 records the results obtained from field sprays of materials which had already proven toxic in laboratory tests. From the counts

TABLE 1. EFFECT OF SPRAY MATERIALS ON NYMPHS OF GRAPE LEAFHOPPER IN FIELD

Material per 100 gal.	Average nymphs per leaf	Total nymphs counted	Number killed	Per cent killed	Remarks
Cocotine 5½ lb.	16	80	71	88.7	Foliage severely burned.
Same in Bordo mixture 8-8-100	18.6	93	76	81.7	Foliage slightly burned; Mixture separates on standing
Derrisol 1 pint	27.4	137	137	100	
Same in Bordo mixture 8–8-100	23	115	113	98	
Pyrethrum soap emulsion 6½ gal.	25.6	128	128	100	
Same in Bordo mixture 8–8–100	18.8	94	94	100	
Black Leaf 40 1 pint	13.8	69	68	98	
Same in Bordo mixture 8-8–100	14.8	74	74	100	
Bordo mixture 8-8-100	13.6	68	7	10.2	
Unsprayed check	17.6	87	5	5.7	

made 24 hours after spraying it will be seen that emulsions of derris ("Derrisol"), and pyrethrum killed the nymphs equally as well as nicotine sulfate, all three materials giving practically perfect control. Moreover they showed no decrease in toxicity when combined with Bordeaux mixture and did not injure the foliage. The emulsion of coconut fatty acids ("Cocotine"), was less toxic, did not mix with Bordeaux, and burned grape foliage. A few nymphs were killed by Bordeaux mixture. The cause of this will be discussed later.

Table No. 2 shows the effect of these same compounds on the nymphal development, particularly the hatching of first instar nymphs. Cages were placed over the foliage immediately after spraying to exclude migrating nymphs and adults, and adults which had survived the spray were removed. Counts made for a period of five days showed that nymphs continued to hatch from unsprayed foliage and from that sprayed with Bordeaux mixture. No first instar nymphs hatched from

TABLE 2. LEAFHOPPER POPULATION ON CAGED FOLIAGE FIVE DAYS AFTER SPRAYING

Material per 100 gal.	Average nymphs per leaf before spray	Average nymphs per leaf after spray	Approximate control %	Average nymphs per leaf by instars after spraying 1	2	3	4	5
Cocotine 5½ lb.	16	4	75	1.7	.8	.8	.4	.3
Same in Bordo mixture 8–8–100	18.6	8.5	54+	1	1.8	1.5	1	3.1
Derrisol 1 pint	27.4	.9	98+	.8	.1	0	0	0
Same in Bordo mixture 8–8–100	23	.6	96+	.23	.07	.07	.3	0
Pyrethrum soap emulsion 6½ gal.	25.6	0	100	0	0	0	0	0
Same in Bordo mixture 8–8–100	18.8	0	100	0	0	0	0	0
Black leaf 40 1 pint	13.8	1.1	90+	0	0	.10	.50	.50
Same in Bordo mixture 8–8–100	14.8	1.3	91+	0	.28	.14	.42	.42
Bordo mixture 8–8–100	13.6	18.2	—	2.6	1.2	3.3	4.0	7.0
Unsprayed check	17.6	20.2	—	3.7	5.7	4.8	2.8	3.0

that sprayed with nicotine or pyrethrum soap emulsion, but hatching continued with the emulsions of derris and coconut fatty acids. A complete disappearance of all instars for the five day period resulted on foliage sprayed with pyrethrum soap emulsion, while with the other materials some nymphs survived, particularly those in the 4th and 5th instars.

In addition to the compounds just discussed, certain other materials were tested in the laboratory and these results are shown in Table No. 3. Sodium fluosilicate in water 1–10 and combined with hydrated lime or Bordeaux mixture killed the nymphs very effectively but burned foliage unless an equal quantity of lime was used with it. Ortho-toluidine emulsion was also quite toxic, but it too burned foliage and did not mix well with Bordeaux. As previously noted, Bordeaux mixture 8–8–100 killed small numbers of the nymphs and various strengths of this material were included in this series and compared with other copper fungicides. These tests showed that Bordeaux mixtures are toxic to small numbers of nymphs in direct proportion to their strength, a 12–12–100 mixture killing about three times as many nymphs as the 8–8–100 mixture. This killing seemed due to the gelatinous consistency of the mixtures and to the caustic action of the lime. Part of the nymphs killed were found glued fast to the leaf surface by the spray film and the remainder developed brown shrunken areas on the body and died 24–48

TABLE 3. EFFECT OF SPRAY MATERIALS ON NYMPHS OF THE GRAPE LEAFHOPPER IN LABORATORY

Material per 100 gal.	Average nymphs per leaf	Total nymphs counted	Number killed	Per cent killed	Remarks
Orthotoluidine emulsion 20 lb.	20.3	61	61	100	
Same with Bordo mixture 8–8–100	21	63	57	90.4	Mixture turns lead colored, materials separate and foliage burning results
Sodium fluosilicate 10 lb., hydrated lime 10 lb.	20	60	60	100	Foliage moderately burned.
Same with Bordo mixture 8-8–100	21.6	65	65	100	Foliage very slightly burned, killing of entire number of nymphs required 48 hours, i. e., 96.9% died in first 24 hours
Hydrated lime 10 lb.	20.8	104	6	5.7	
Bordo mixture 8–4-100	33.4	167	12	7.2	Foliage very slightly burned
Bordo mixture 8–8–100	27.3	219	23	10.5	
Bordo mixture 8–12–100	31.8	159	31	19.5	
Bordo mixture 12–12–100	31.3	94	30	31.3	
Ammoniacal copper carbonate 6–12–100	20.3	61	0	0	
Copper hydroxide 6 lb.	26	104	5	4.7	
Check	14	56	1	1.8	Sprayed with plain water

hours later. The same behavior was noted to a less extent in nymphs sprayed with hydrated lime and with copper hydroxide, but not with ammoniacal copper carbonate. In the check material a few nymphs died while attempting to moult. Bordeaux and lime sprays tended to increase this phenomenon.

ORIENTAL FRUIT MOTH EXPERIMENTS

During the course of the grape leaf-hopper work investigations were in progress with the second generation of the oriental fruit moth and twigs containing larvae were treated with the emulsions which proved successful in leaf-hopper control. None of these killed the larvae within the twigs but it was observed that pyrethrum soap emulsion often stunned them to such an extent that they were unable to infest new twigs.

This material was included in the routine fruit moth work, which consisted of a laboratory investigation of a number of spray materials, and

TABLE 4. EFFECT OF CAGING ORIENTAL FRUIT MOTH LARVAE WITH SPRAYED OR DUSTED FRUIT. INDIVIDUAL PEACHES USED

Liquids: Material per 100 gal.	Total larvae used	Total killed	% killed	Effect in relation to size of larvae: 2–5 mm. No. entered	No. dead	6–9 mm. No. entered	No. dead	10–15 mm. No. entered	No. dead	No. in cocoon
Pyrethrum soap emulsion 10 gal.	15	7	46.6	1	4	3	2	1	1	3
Same in Bordo mixture 8–12–100	12	9	66.6	0	3	0	3	1[1] 2[4]	3	0
Pyrethrum soap, Bordo 8–12–100 Sodium fluosilicate 10 lb.	16	13	81.2	0	1	1[3] 1[2]	3	0	5	5 4[2]
Pyrethrum soap, Hydr. lime 20 lb. Sodium fluosilicate 10 lb.	14	10	71.5	0	2	2		2	2	0
Hydr. lime 20 lb. Sodium fluosilicate 10 lb.	11	10	90.9	0	4	1	2	0	4	0
Bordo mixture 8–12–100, Sodium fluosilicate 10 lb.	16	8	50	0	4	0 4[4]	2	0 2[4]	2	2
Black leaf 40 1 pt. Hydr. lime 12 lb.	14	4	28.5	2	4	4	0	2	0	2
Kerosene Emulsion 7%	10	2	20	2	2	0 2[4]	0	0 2[4]	0	2
Lead arsenate 2 lb. Hydr. lime 4 lb.	12	3	25	3	3	3	0	0	0	3
Unsprayed check	12	0	0	0	0	6	0	3	0	3
Dusts: Pyrethrum 5 parts, sodium fluosilicate 1 part Hydr. lime 5 parts	17	12	70.6	0	4	4	3	0	3	2[2]
Sodium fluosilicate 1 part, hydr. lime 10 parts	10	6	60	0	2	4	2	0	2	0
Nicotine-lime dust 4%	6	2	33.3	0	2	2	0	2	0	0

[1]Larva entered thru injury.

[2]Larvae abandoned cocoons and died.

[3]Larva abandoned fruit and died.

[4]Larvae missing.

field tests of those which were found promising and safe for commercial use.

In the laboratory third generation larvae of graded size were caged with peaches which had been sprayed or dusted with the various materials. When liquids were used the spray was allowed to dry before the larvae were introduced. Table No. 4 shows the results of these tests. It will be seen that the greatest numbers of larvae were killed by liquid sprays of pyrethrum soap emulsion and sodium fluosilicate in combination with hydrated lime or Bordeaux mixture or with dusts containing similar ingredients.

The effectiveness of the dusts was slightly less than that of the liquids. The greatest protection afforded the fruit, as ascertained by records of larval entrance, was from a liquid spray of pyrethrum soap emulsion, sodium fluosilicate, and Bordeaux mixture. Larvae placed on fruit sprayed with the pyrethrum soap emulsion combinations were characterized by restlessness, unsuccessful attempts to enter the fruit or spin cocoons, gradual paralysis and death. Sodium fluosilicate was more directly toxic and larvae usually died in 48 hours even though they entered the fruit. Larvae 6 9 mm. long were most resistant to all of the materials tested.

As noted by Peterson,[1] dusts containing hydrated lime killed many of the smaller larvae and it is possible that the benefit received from all of the combinations containing lime was in part due to it.

In the field investigations small plots of Elberta peach trees were sprayed and dusted at the time the adults of the third generation were flying in greatest abundance. The second generation larvae had confined their feeding to the twigs and to the fruit of early varieties and the Elberta fruit was practically uninfested.

Sheets were placed under the trees, and the dropped peaches were collected and examined. At harvest the picked fruit was split and the infestation determined. Table No. 5 lists the materials tested and the infestation of the picked and dropped fruit. The only decided reduction in the percentage of wormy fruit occurred in the plot sprayed with pyrethrum soap emulsion and Bordeaux mixture, and the plot dusted with sodium fluosilicate and hydrated lime, the pyrethrum-Bordeaux plot showing 50% infestation, the sodium fluosilicate plot 47%, and the unsprayed check 75% infestation. Sodium fluosilicate in liquid

[1]Peterson, A., Some Studies on the Effect of Arsenical and Other Insecticides on the Larvae of the Oriental Peach Moth; JOURNAL OF ECONOMIC ENTOMOLOGY 13, 4: 391.

form was omitted because of the danger of burning the peach foliage. Coated and colloidal arsenates of lead did not prevent severe infestation of the fruit. A liquid spray of nicotine sulfate and lime reduced infestation to a small extent.

TABLE 5. SUMMARY OF FIELD TESTS FOR ORIENTAL FRUIT MOTH CONTROL

Liquids: Material per 100 gal.	Number fruit examined	Number fruit infested*	% fruit infested	% dropped fruit infested	% picked fruit infested
Pyrethrum soap emulsion 10 gal.					
Bordo mixture 8–12–100	637	321	50.3	94.7	49
Kerosene emulsion 7%	435	306	70.3	82	69.5
Black leaf 40 1 pint, hydr. lime 10 lb.	361	232	64.2	71.4	63.3
Lead arsenate 2 lb., hydr. lime 4 lb.	230	193	83.9	86.6	84
Colloidal lead arsenate 1½ lb.	228	158	69.3	85.7	67.8
Coated (oleate) lead arsenate 10 lb.	136	104	76.4	83.3	76.1
Unsprayed check	143	107	74.8	100	71.3
Dusts: Sodium fluosilicate 1 part					
Hydr. lime 10 parts	655	306	46.7	68.1	45.9
Nicotine lime dust 4%	175	142	81	94	76

*All fruit split to determine infestation.

MR. H. L. DOZIER: What is the pyrethrum soap that you used?

MR. J. R. EYER: The "Jap beetle Whiz spray." We didn't have enough of the soap prepared by the Japanese Beetle Laboratory to use it in all our experiments. What we used here was the regulation "Jap beetle Whiz spray" manufactured by R. M. Hollingshead Company, Camden, N. J.

MR. H. L. DOZIER: What strength?

Mr. J. R. EYER: One gallon of the spray to fifteen gallons of water.

MR. H. L. DOZIER: I used this same preparation, at the rate of one to one hundred and one to fifty against the apple leafhopper and the grape leafhopper, and we got excellent results at a temperature of about 100, I think it was. When it dropped to 64 it was an absolute failure.

MR. J. R. EYER: Our temperature at the time this spraying was done was between 70 and 75. I know that on the leafhopper you can use it at a lower strength than we did in the field; we kept those high strengths on the peach because we knew that it would take the highest strength possible on the peach to have any effect on the moth, and even then it didn't have much. The fact that none of the leafhopper eggs hatched from the foliage after it was applied seemed to indicate that it has the same type of ovicidal value as Ross noted for nicotine.

MR. T. H. PARKS: We had one grower in Ohio last year who was made violently ill and required the services of a physician. He had been spraying with nicotine and bordeaux mixture for years and had never had such ill effects before to my knowledge.

MR. J. R. EYER: I didn't note that trouble with the pyrethrum at all. I always get sick with nicotine, because I don't smoke, I guess.

MR. F. C. NELSON: I worked with pyrethrum sprays all summer in clossed buildings where the air was so thick with some of the commercial fly sprays that you couldn't see across the room, and never noticed any ill effect. I worked with cattle, hogs, and practically all farm animals. I don't think there is a possibility that the pyrethrum spray would make anybody sick.

MR. ROGER BALDWIN: If you will take a cathartic at the end of the day of spraying, you will not have any injurious effect.

PRESIDENT ARTHUR GIBSON: We will now listen to a paper by C. C. Hamilton.

THE RELATION OF LEAF AND TWIG GROWTH OF TWO VARIETIES OF APPLES TO THE QUANTITY AND ADHERENCE OF LEAD ARSENATE THROUGHOUT THE SPRAYING SEASON

By C. C. HAMILTON, *New Brunswick, N. J.*

ABSTRACT

Weekly measurements of twig growth in inches and leaf growth in area were made throughout the growing season, on tagged twigs on several apple trees. Foliage was collected at each of the dates of measurements and analyses made for lead arsenate. These results are correlated with the increase in leaf area and twig growth. At the end of the spraying season the leaves on the tagged twigs were collected, separated into groups according to the dates when they first appeared and analyses made for lead arsenate These results are correlated with the growth of leaf area.

(Withdrawn for publication elsewhere)

PRESIDENT ARTHUR GIBSON: V. I. Safro will now present a paper.

ADAPTING FUMIGATION PROCEDURES TO INDUSTRIAL NEEDS

By V. I. SAFRO, *Arcade Station, Los Angeles, Calif.*

ABSTRACT

Discussing some basic principles of industrial fumigation, including the dosage range, air circulation during fumigation, penetration, retention and correcting some former ideas on absorption of HCN by foodstuffs.

In the course of many experimental and commercial fumigations conducted by the writer for the control of insect pests as industrial

problems, a number of procedures usual in agricultural work were found unsuitable for industrial use. Some former basic concepts required radical modification and occasionally the establishment of entirely new principles.

This paper discusses briefly several of these new and modified principles. The writer's fumigations have been almost entirely with commercially pure calcium cyanide, but the principles involved apply generally to all fumigations.

Food, clothing and shelter continue to be the objects of insect attack after the materials have left the field as growing agricultural crops and entered the industrial world as basic commodities. Modern concepts of sanitation call for measures of insect control that, because of the closer contact of the problems with our every day lives, are far more pressing than the original problem affecting the growing crop. The agricultural crop called for protection from destruction and deterioration. Industry calls for protection not only from direct injury to its products but also from those many conditions that may affect the physical welfare or even the mental attitudes of its workers, its customers or the general public.

Agriculturally—as the word is generally used—the presence of predaceous insects is very much desired. In a package of cereal, however, a predaceous insect is as objectionable as the pests it preys upon. Parasitized insects are welcome sights in agricultural infestations, but there is nothing to inspire welcome in the sight of parasitized larvae in a package of dried fruit.

Considerable financing is conducted at present based upon stocks of agricultural products in bonded warehouses. Tobacco, grain, wool, peanuts, beans, dried fruits, may lose much or all their value if not properly protected from insect pests. Railroad, steamship and insurance companies are faced with claims for insect damage to freight and cargo, on the complaint that the infestations took place in transit.

The Dosage Range

In the literature recommendations generally give a fixed dosage and exposure without regard to practicability. The simplest example of this type of problem—household fumigation—may be taken. Published recommendations generally call for an overnight exposure—or even longer. To most families it is a hardship to remain away from home overnight. It is expensive. And yet, too often, the literature offers no relief—notwithstanding that household fumigation for insect pests can now usually be conducted effectively in a few hours.

Dosages can generally be worked out for an entire range of exposures from minimum quantity of fumigant on the one extreme to minimum length of exposure on the other. The interest affected can then choose the dosage and exposure that more nearly meets its requirements. In ship and car fumigation the time element is usually of major importance and the shortest exposure would be preferred. In warehouse fumigation frequently the lowest dosage would be preferred—with overnight or week-end exposures.

Air Circulation and Penetration

A dosage range worked out for an insect not buried in any medium gives no indication as to dosage ranges necessary for the control of the same pest when it occurs in commercial packing. A dosage range for commercially packed material must be worked out for each type of packing. Fine flours will be more difficult of penetration than coarse cereal products. Pressed products are more difficult of penetration than those loosely packed.

Penetration must be obtained at minimum interference with the industrial procedure concerned. Installation of expensive vacuum equipment is not often permissible or practical. The fumigation procedure must be worked out in a manner that will not call for more than minor changes in the structure of the building or any of its rooms.

In adapting fumigation procedures to industrial needs the writer has found that penetration is considerably increased by circulating the air in the room or building during the fumigation. This principle is now being used by the writer in all fumigations that include a penetration problem.

Air circulation during the fumigation increases efficiency in several ways. More efficient diffusion of the gas takes place and the air movement tends to displace dead air in the packing with the poisoned air circulating in the room. Where calcium cyanide is used as the fumigant, air circulation insures the more complete contact of atmospheric moisture with the calcium cyanide particles, a more complete evolution of HCN and a higher concentration in a shorter period of time than if no air circulation is provided.

Retention of Gas in Packed Material

The retention of gas in the fumigated package is undoubtedly a factor in the insecticidal efficiency of fumigations. It is known definitely that the gas does not immediately leave the package at the end of the commercial fumigation. Its rate of departure depends upon many

factors, such as density and humidity of the product itself, penetrability of the packing material, ventilation, etc., though in some instances the retention may be so poor as to be negligible as a commercial factor. To investigators this principle is significant in that the factor of time elapsed between the end of the fumigation proper and the opening of the package may affect the results of experiments. In working out a dosage range on packed material, the mortality examinations could well be made after an interval of time sufficient to permit of the full effect of any retained gas. This factor, if present at all, would certainly be active under commercial conditions, for, after all, in actual practice very few, indeed, are the cases where the product is unpacked immediately after the fumigation.

Absorption of HCN by Foodstuffs

Unfortunately, too much information on the absorption of HCN by foodstuffs has been misleading. To record in scientific publications the results of routine analyses of foodstuffs for the presence of HCN is, of course, permissible as contributions to our technical knowledge of the subject. To issue such information broadcast to the non-technical reader is unfortunately likely to add to the misinformation he already has on the subject—even when qualifying statements are included indicating the lack of real significance of the analyses made.

An analysis showing presence of HCN in foodstuffs does not definitely indicate (except under extreme conditions) whether the product is likely to be injurious to human health. It is a well-known practice of fumigators, after the fumigation of restaurants, ships and similar places in which ready food is stored, to partake of the fumigated food immedately after clearing the gas. The writer has, without any ill effects whatever, partaken heartily of fumigated sliced bread, cut pie, sticky figs, coffee and other foods shortly after the completion of fumigations. Undoubtedly, analyses of this food would have shown the presence of HCN, and there is no question whatever that much food containing traces of HCN is eaten without immediate or cumulative effects of any kind.

A statement of the percentage of HCN in food would hardly indicate its safety without the additional information as to the probable amount of such food a normal person would have to eat at the time of the analysis in order to show toxic symptoms. Analyses of foodstuffs for the presence of HCN should be made in accordance with quite evident—but generally overlooked—factors, especially in the fumigation of commercial establishments in which food products are manufactured or stored. Not

only should the normal interval of time between the fumigation and the time the article reaches the consumer elapse before the analysis is made, but the handling of the product commercially should be duplicated in order to arrive at analyses that would more nearly approach actual conditions in commercial practice; such as transportation in freight cars under more or less ventilated conditions, handling out of the cars into warehouses, shipment out of warehouses by trucks to stores and handling of indivudual packages from stores to the consumer.

In addition to time elapsed and handling in transportation, foodstuffs should be subject to the usual kitchen and table preparations before analysis; such as mixing with other ingredients, sifting, dissolving, cooking, slicing, etc. Even in the simplest case, such as cheese, a logical analysis cannot be made without first slicing the cheese—assuming, of course, it is that type of cheese. To analyze uncooked flour for traces of cyanide would be just as misleading—naturally, the flour should be properly prepared and baked. Then it is in order to make an analysis of the edible product. The factors of increased aeration, dilution and possible decomposition enter so prominently into food preparation that it is quite inconceivable to permit of analyses with any practical significance without taking them into consideration.

Some Evidences of Industrial Interest

A number of industrial practices at present under way indicate the importance with which fumigation is being regarded industrially. The widespread adoption of flour mill fumigation is well known. The fumigatorium is finding an established place in a number of industries; such as tobacco, package cereals, beans, dried fruits, furs and warehousing. It often does double duty—it serves its purpose for outgoing shipments, to protect the consignee, and also for incoming material for the protection of the foods and premises concerned.

One large dried fruit organization guarantees its products to arrive insect-free in the hands of the consumer throughout the world. Cereal mills are beginning to advertise insect-control treatment of their products. Cigar factories are including in their service fumigation of all shipments. It is a usual practice in the two latter industries to accept the return from purchasers of infested material—even in cases where it is quite evident the infestation occurred in transit or on the premises of the purchaser himself.

Warehouses are featuring fumigation as part of their service. One of our largest railroads has recently appointed a fumigation manager, who is organizing a department to take over the railroad's fumigation

activities. One of the largest chains of flour mills, warehouses and elevators in the country recently assigned a member of its organization to an investigation of fumigation procedures with the intent of establishing a complete program of insect control from the line elevator to the consumer of the manufactured cereal product.

The fumigation of empty cars, ships and other channels of trade is being advocated and slowly adopted. An evidence of the interest in this matter is a recent meeting of representatives of the export flour milling industry, railroads, steamships and marine insurance, to consider ways and means of reducing insect infestation of mill products in transit.

All of these developments indicate the need for greater extension of fumigation procedures to meet industrial demands. They indicate the need of proper coordination of the investigations to the industries concerned, with the findings, written after some practical contact with the industry and in the language familiar to it, finally recorded in the proper trade publications.

Mr. Perez Simmons: I should like to ask Mr. Safro if it is dangerous to fumigate any raw food products. Ordinarily the recommendations have been to remove milk from dairies.

Mr. V. I. Safro: Many food products are regularly fumigated. The Bureau of Animal Industry has approved fumigation of meats with HCN. That was a number of years ago. Milk, coffee and a few such things are occasionally removed before fumigation, but in actual practice, such as ship fumigation, there is no food removed from the kitchen, or whatever they call it on board a ship. The same holds true in restaurants and hotels. Sometimes cut onions and such things are removed, but the usual experience is to disturb nothing at all until after the fumigation, and then the fumigating crew usually helps itself to what there is in the kitchen, with no ill effects.

I have gone through the literature, not only the technical but the commercial and the popular, and have had correspondence with a number of practical as well as technical fumigators and also correspondence with investigators. I don't know of a single case of human poisoning from food that had previously been fumigated.

Mr. Perez Simmons: Nearly all the trouble has been due to carelessness on the part of the fumigators or due to accidental injuries to people who have been in the fumigated areas.

Mr. V. I. Safro: Yes, the troubles that have been recorded are generally inhalations of the gas rather than ingestion of the food that

has been fumigated. After all, a chemical anaylsis will indicate such minute quantities of HCN in the food product as to mean nothing practically.

MR. WILLIAM MOORE: The United States Health Service have carried out a few experiments with mice and fumigated bread. They killed a few mice when the bread contained so much gas that the miee were killed before they ate the bread, but as long as the mice were able to live through the gas and eat the bread, they survived. (Laughter.)

PRESIDENT ARTHUR GIBSON: The next paper is by B. F. Driggers.

CALCIUM CYANIDE AS A CONTROL FOR THE CRANBERRY ROOT WORM ON CULTIVATED BLUEBERRIES[1]

By BYRLEY F. DRIGGERS, *Associate Cranberry Specialist, New Jersey Agricultural Experiment Station, New Brunswick, New Jersey*

ABSTRACT

The cranberry root worm (*Rhabdopterus picipes* Oliv.), a common insect on cranberry bogs, has become recently an important enemy of the cultivated blueberry. An outline of the life history and habits of the larvae and adults is given. Experiments with sodium fluosilicate used against the adult failed to give a satisfactory kill. Experiments with both the dust and granular calcium cyanide used against the adults indicate that the insect can be controlled with the granular calcium cyanide.

INTRODUCTION

The cranberry root worm[2] has been known for a number of years as a feeder on the roots and foliage of cranberries and other bog plants, including the swamp blueberry. Damage from this insect in the past has usually occurred on the so-called savannah bogs the soil of which is made up chiefly of sand. During recent years a number of old run-down or abandoned savannah bogs have been plowed up and made into blueberry plantings. The clean cultivation of the plantings caused the beetles to concentrate on the blueberry plants in such numbers that it became necessary to work out some measure of control. This paper is a summary of the main points brought out in the investigation of the subject during the past year.

HABITS OF THE LARVAE AND ADULTS

The principal damage to the blueberry plant is caused by the larvae feeding on the small, fibrous roots. The larvae feed throughout the summer and pass the winter in the soil. Pupation takes place the

[1]Paper No. 330 of the Journal Series, New Jersey Agricultural Experiment Stations, Department of Entomology.

[2]*Rhabdopterus picipes* Oliv. Fam. *Chrysomelidae.*

following spring or early summer, according to Scammell (4), who worked out the life history of this insect. The adults begin emerging about the middle of June and are to be found in maximum numbers during the latter part of June and the first of July. The beetles feed to some extent on the foliage at night and on dark cloudy days. On bright, sunny days they are to be found under loose soil, leaves and other places of concealment at or near the base of the plant. Field collections showed that the majority of the beetles find shelter within eighteen or twenty inches of the plants. With the above mentioned habits of the beetle in mind, we decided to test two of the more recent insecticides; namely, sodium fluosilicate and calcium cyanide.

Results Obtained with Sodium Fluosilicate

Preliminary laboratory and field experiments with the so-called "light" and "extra light" sodium fluosilicate gave little or no control. The detailed experimental procedure is omitted here. However, certain observations on the actions of the beetles when in contact with the sodium fluosilicate may be of interest. On coming in contact with the dust the beetles became extremely active. They would attempt to fly and, falling back, would crawl aimlessly over the bottom or up the sides of the cage. The beetles would stop frequently and rub their legs together in an effort to free themselves of the dust. At no time were the beetles observed cleaning their feet with their mouth parts. In this last point the actions of the cranberry root worm differ from those of blister beetles, the Mexican bean beetle and the cotton boll weevil as reported by Ingram (1), Marcovitch (2) and Osburn (3) respectively. This difference in the actions of the cranberry root worm and the actions of the other insects mentioned explains possibly the difference in control.

Preliminary Tests with Calcium Cyanide

The calcium cyanide used in the following experiments was the Grade "A" Cyanogas dust and the granular calcium cyanide furnished by the American Cyanamid Company of New York City. The experimental procedure was as follows: Twelve blueberry nursery plants about a foot in height were covered with suitable wire cages. Ten beetles were introduced into each of the twelve cages. As soon as the beetles had concealed themselves around the base of the plants, one-tenth ounce of the calcium cyanide dust was sprinkled around each of five plants. Five of the remaining seven plants were treated with an equal quantity of the granular material. The soil around the ten treated plants was stirred lightly in order to mix the calcium cyanide with the

moist soil and to bring the beetles in contact with the gas. The number of apparently dead beetles at the end of one, three and twenty hours is set forth in Table 1.

TABLE 1. TEST OF CALCIUM CYANIDE DUST AND GRANULES USED AGAINST THE CRANBERRY ROOT WORM. TEN BEETLES TO EACH CAGE

Number of cage	Material used	No. apparently dead beetles 1 hr.	3 hrs.	20 hrs.	Remarks
1	Dust	10	9	8	
2	Dust	9	9	7	
3	Dust	10	9	8	
4	Dust	10	10	8	
5	Dust	9	9	9	No injury to plants after treatments
6	Granular	10	10	10	
7	Granular	10	10	10	
8	Granular	10	10	10	
9	Granular	10	10	10	
10	Granular	10	10	10	
11	Check	0	0	0	
12	Check	0	0	0	

An examination of the data in Table 1 shows that, of the two types of material, the granular calcium cyanide was the more effective. A complete kill was obtained with this material. In the case of the dust all of the beetles except two appeared to be dead at the end of one hour. At the end of three hours two of the apparently dead beetles in the dust cage had recovered and at the end of twenty hours six more had recovered. It appeared that the evolution of the gas from the fine dust particles was so rapid that the beetles were not exposed to a lethal concentration of the gas for a sufficient length of time to obtain a complete kill.

FIELD TESTS WITH GRANULAR CALCIUM CYANIDE

The cage experiments mentioned above were carried out June 29th–30th. On July 10th, the soil around fifteen of the more heavily infested field plants was treated with one-half ounce granular calcium cyanide to each plant. The cyanide was sprinkled around the plants in a circular area extending about a foot from the plant. Immediately after the material was applied the soil was raked lightly toward the plant. This procedure mixed the calcium cyanide with the moist soil and uncovered many of the concealed beetles. The treatments were made about noon on a clear day with the temperature of the air at 32°C.

Three hours after the treatments were made the loose soil from around five of the treated plants was scooped up and screened to recover any beetles present. Over 95% of the beetles were found dead. The detailed results are set forth in Table 2.

TABLE 2. RESULTS FROM FIELD TEST WITH GRANULAR CALCIUM CYANIDE USED AGAINST THE ADULT OF THE CRANBERRY ROOT WORM

No. of plant	Amt. cyanide used	No. dead beetles	No. live beetles	Remarks
1	.5 oz.	11	1	
2	.5 oz.	23	0	No injury to
3	.5 oz.	21	3	plants after
4	.5 oz.	21	0	treatment.
5	.5 oz.	9	0	

No injury was noticed on any of the plants after the treatment. Additional tests were run to determine what dosages would cause injury to the plants. Five plants were treated with dust and five with the granular material in amounts ranging from one-half to two and one-half ounces. Foliage in contact with or near the soil was burned slightly with dosages of one and one-half ounces or above. As the damaged foliage was chiefly sucker growth, which is removed by the winter pruning, the real damage to the plants was practically nothing even in dosages as high as two and one-half ounces. The average moisture content of the soil around the treated plants was 15.6% and the average soil temperature was 28.4°C.

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PRESIDENT ARTHUR GIBSON: We will now listen to a paper by C. O. Eddy.

CYANOGAS CALCIUM CYANIDE FOR HOUSEFLY FUMIGATION IN CERTAIN TYPES OF BUILDING

By C. O. EDDY, *S. C. Experiment Station*

ABSTRACT

Hydrocyanic acid gas derived from Cyanogas calcium cyanide has proven an effective and economical fumigant for houseflies at Clemson College, S. C., during the past season, especially in large rooms such as dairy barns, stores, shops, laboratories and under certain conditions in homes. The calcium cyanide was usually applied as a dust cloud thrown vigorously and horizontally from a cupped stiff paper held in the hand. In homes, feed rooms for animals and in other rooms where a dust cloud could not be used or where it was not advisable to have the dust fall to

the floor, the calcium cyanide was applied as a thin film on papers placed in several parts of the room. The normal dosage used in commercial control ranged around ½ ounce per 1000 cubic feet, being slightly less in large rooms with very little leakage and more as the leakage increased, the increase being greatest in the smaller rooms. Night fumigations were more convenient and were usually more effective. The evolution of the gas from the dust clouds was slow enough to allow sufficient time for a thorough application, and the concentration of hydrocyanic acid gas necessary for a lethal dosage for flies is low enough to allow a considerable margin of safety for the operator.

In spite of the fact that it is better to control the maggots of the housefly it is often desirable and sometimes very necessary or urgent to control the adults. The latter condition prevailed at Clemson College, S. C., due to the great abundance of houseflies that existed throughout the last season. Experiments were therefore conducted to determine an economical method of control that not only could be easily applied but would be adaptable to large scale control. Traps and poison solutions had but very little value. Black Flag, commercial pyrethrum and the more recently developed oil sprays had their usefulness under certain conditions but their cost was high.

The experiments reported in this paper represent results for only one season but they were so highly satisfactory it is thought that they will be interesting and useful to other Entomologists. These results were obtained during a hot and very dry summer. The former, at least, may be considered a favorable condition for Cyanogas calcium cyanide as an insecticide.

Object

The object of the experiments reported in this paper was to determine the value of hydrocyanic acid gas derived from Cyanogas calcium cyanide as a housefly fumigant.

Method of Application

Nearly all of the calcium cyanide used in the housefly control tests reported was applied as a dust cloud without the aid of a dust gun. Small amounts of calcium cyanide were successively poured on a strong paper or cardboard that was slightly cupped as it was held in the hand. Each portion of dust was then thrown vigorously and horizontally from the operator so that a dust cloud was formed. The dust was distributed as evenly and uniformly throughout the rooms fumigated as conditions would permit, care being taken that the operator would not have to walk through the dust cloud. The operator has, however, walked through these dust clouds but has always held his breath when doing so. The gas from these clouds of dust spread slowly enough so that there

was always sufficient time to make a thorough application of the poison. The evolution of the gas from the cloud of dust also takes some time, which in addition to the diffusion of the gas in the air, adds to the safety of applying the dust. The question of the margin of safety relative to the concentration of hydrocyanic acid gas necessary for a lethal dosage to flies is included in the section "DISCUSSION."

In certain shops, feed rooms for animals, and other rooms where a dust cloud could not be used or where it was not advisable to have the dust fall to the floor, the calcium cyanide was applied as a thin film on papers placed on the floor so that the hydrocyanic acid gas would uniformly diffuse throughout the room.

PRELIMINARY TESTS

A few tests were conducted in a large laboratory in the Agricultural Building where a considerable number of houseflies accumulated each day. This room contained 18,772 cubic feet. It had plastered brick walls and well-fitted windows and doors so that the amount of leakage was small. The tests were usually started at night after the flies had collected in the upper portion of the room and discontinued the next morning. Rooms were well ventilated when opened but were occupied at once.

A dosage of eight ounces of calcium cyanide per 1000 cubic feet was used in the first test. This gave 100% control. A dosage of ⅛ ounce per 1000 cubic feet was then used and many flies survived but enough were killed to indicate that the first dosage was far too high and that a small dosage would probably be sufficient. Three-fourths of an ounce of calcium cyanide was then used and 100% control was again secured. Other tests gave results as follows: .30 ounce gave 100% control, .27 ounce gave 98% control, .24 ounce gave 99% control, and .14 gave from 60% to 70% control. These results indicated that a dosage of slightly less than ½ ounce calcium cyanide per 1000 cubic feet could be used for night fumigation in relatively large rooms having very little leakage. In practice ½ ounce per 1000 cubic feet was used in this room to obtain control.

It was found in certain experiments started before the flies were all in the upper portion of the room, that those concealed in waste paper baskets or other low places often did not receive a lethal dosage. These slowly recovered and were active for a time at least. This indicates that places concealing or protecting flies should have a small portion of the dust scattered in or about them. This will either kill the flies

in situ or drive them out to be killed as they fly in the greater concentration of gas in the higher parts of the room.

The expended residue on the concrete floor was swept up the next morning. This was done by the negro janitor who experienced no discomfort.

Cage Tests

In order to study the effect of the distribution of gas concentrations in different parts of a room being fumigated and the consequent effect on houseflies, fumigation tests were conducted in several laboratories where flies were confined in wire cages placed in different situations. Since the previous experiments primarily concerned flies in the upper portion of the room, this test was conducted chiefly to determine the effect on those in the lower spaces—9 feet and below.

The cages were built of 16 mesh screen wire, 18 inches in height, 15 inches in diameter and with a solid top. Between 100 and 200 flies were caught in each cage by swinging it through their swirling masses, in a feed room where they were abundant. Cloth was then tied over the bottom to prevent escape. Three of the cages containing houseflies were usually placed in each room to be fumigated, one being placed on the floor, one on a table or cabinet with a large top and the third on an electric light cord about 9 feet from the floor. Cages were read about two hours after the tests were discontinued.

The cage experiments were conducted with varying dosages and time exposures. With a dosage of one ounce of calcium cyanide per 1000 cubic feet the control approximated 100% with the exposures of one, two, three, and five hours. The variation in control was very little and was not correlated with the duration of exposure.

With a dosage of ¼ ounce, ½ ounce, or ¾ ounce in the same situation, however, the longer exposures were more effective. The five hour exposure was thus more than twice as effective as the one hour exposure. The ½ and ¾ ounce dosages gave commercial control since they gave 92% and 96% control respectively in the long period tests. In short tests they were inadequate for these low cages. For night fumigations when the flies were in the upper portion of the rooms the results might have been better. The ¼ ounce dosage per 1000 cubic feet was not adequate for control even during the long exposures.

When one ounce of calcium cyanide was used per 1000 cubic feet the results in control obtained in cages at different elevations and in different situations were very uniform. With the lower dosages, however, the contrast was more evident. The highest cages when hanging free in

space had the highest per cent of dead flies. Cages on tables with large tops, on cabinets especially in corners, or near windows often gave less control than that secured in cages on the floor. This indicates that when fumigation is done in the daytime, at least, a small portion of the dust should be scattered in places where the gas does not circulate well, especially if flies are present in these places.

One series of tests was conducted in a small dark room which was unusually high in proportion to the floor size. Control in this room was always very poor. It was thought at first that the damp unplastered brick walls might have been a factor. However, a test was being conducted in another dark room of normal proportions where the walls were unplastered and as moist but where the control secured was uniform with that in the other rooms. It seems, therefore, that because of the unusual height of the room in contrast to its width and length, the hydrocyanic acid gas rose quickly to the upper portions of the room so that only a very small amount of it diffused through the air in the lower part and this was not effective against the flies which were in cages on or near the floor. Thus it may be necessary to increase the dosage in rooms that are excessively high in proportion to floor size, especially if the fumigation is done during the day.

All of these tests were conducted in basement laboratories while the rooms above were occupied. The only ceiling leakage was around pipes that went through to the rooms above. This leakage was never noticed. When rooms were opened after a test some gas escaped into the hall which rose to the third story but this never caused any inconvenience or interfered in any way with the work on that floor.

Tests in Stores

A series of tests was conducted in several grocery stores, restaurants, and drug stores including bóth brick and frame structures. The volume of the rooms fumigated usually ranged from 10,000 to 15,000 cubic feet. In order that the first experiment might be certain to give satisfactory control one ounce of the calcium cyanide per 1000 cubic feet was used. This gave 100% control, as far as could be ascertained. In the later tests the ½ ounce dosage was used. The control secured was always 100% or very near to it. In one very irregular corner room with many windows and doors a very few flies often escaped when this dosage was used.

Flies caught between screen doors and the main door should be driven out before the fumigated rooms are entered.

The owners and managers of these stores were enthusiastic about the economical and satisfactory housefly control so easily obtained. They often asked for additional fumigations.

Hog Feed Room

A feed room for hogs of about 1000 cubic feet capacity was fumigated a number of times for flies that accumulated in immense numbers each day. It was estimated that 400,000 flies were in it during each fumigation. The room was a frame structure with weatherboards on the outside and ceiling on the inside. Two single windows and a door occupied three sides. There was a large amount of leakage, part of which was closed with wet paper and burlap. The calcium cyanide was applied as a thin film on newspapers. The results of these fumigations may be summarized as follows: .54 ounce of calcium cyanide per 1000 cubic feet gave 50% control of the flies, 1.50 ounce and 2.18 ounce dosages gave 99.9% control and the 3.27 ounces gave 100% control. The one ounce dosage gave commercial control, as in any case it was necessary to repeat the control very often due to the fact that great numbers of flies entered during each day. On windy nights the loss of gas on the windward side was very great, so this may have accounted in part for the necessity of so high a dosage.

House Fumigation

A little additional information was derived by using calcium cyanide in the home of the writer. The dust was applied on newspapers in every case. The dosage was higher because the building was a frame structure and the ceiling above loosely fitted.

Fumigation tests were conducted when rooms below and adjacent were occupied. No tarnishing of walls, or household equipment was ever noted.

Dairy Barns

Fumigation tests were usually conducted at the dairy barns at night, *after the stock had been turned out*, beginning about 10 P. M. and being discontinued about 4 A. M. The illustration, Plate 5, shows the inside of one of these barns. It has three large ventilators about two feet in diameter, a large number of windows fitted only moderately tight, one set of large double sliding doors at either end in the middle and a double height door at one end in each corner. A very large amount of leakage occurred around the doors and some around the windows but this did not necessitate the increase in dosage as it did in the small rooms.

The volume of each barn was the same,—64000 cubic feet. The calcium cyanide was dusted uniformly in the three longitudinal alleys and at the ends. In this room much of the dust cloud remained suspended for some time, some of it even rising several feet and spreading so a very thorough mixture of dust and air took place. This resulted in a rapid evolution of the gas that spread to all parts of the room.

A preliminary test using one ounce of calcium cyanide per 1000 cubic feet was first run without the ventilators being closed or the windows being repaired in order to determine whether control in these large rooms would be possible. The test was highly satisfactory, nearly all of the flies being killed, so the ventilators were closed and the broken window panes replaced. The dosage was then decreased to ½ ounce and, again, nearly all of the flies were killed. The flies that escaped were chiefly around the windows but many of the flies even in these situations were killed. Nearly all the flies were on the ceiling at night, however, so those that did not receive lethal dosages were few.

A dosage of three-fourths ounce with the ventilators open did not give as good control as the half ounce dosage with them closed.

When fumigations were conducted during the day some flies escaped through the leakage around the doors at the ends. Some of the flies near the doors recovered since the toxic gas was around them but for a very short time. Flies in mangers were killed not only more slowly than those on the ceiling but some recovered from the paralysis while a few were only partly affected.

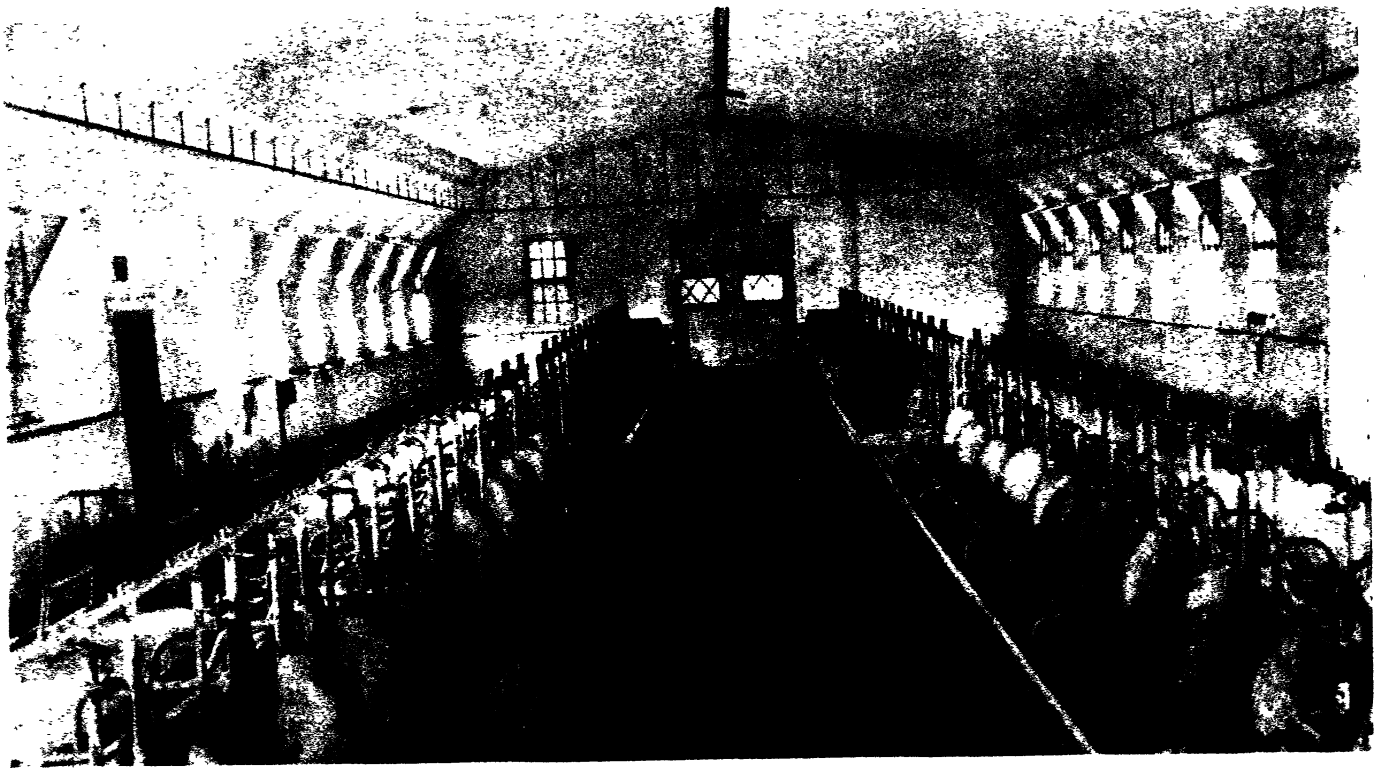
The ½ ounce dosage was used to control flies in the barns in a commercial way after the experiments were discontinued.

Prior to these experiments Black Flag was used twice per week, the application being made from a rotary gun. The duster was operated by a man on top of a tower built on a feed truck that was pushed along the feed alley in the center of the room. The Black Flag cost $2.50 to $3.00. The cost of the two pounds of calcium cyanide for the one-half ounce dosage was 50 cents which represents one-fifth or one-sixth that of the Black Flag fumigation for materials alone. These prices are based on large quantity purchases in both cases. In addition the use of the dust gun and services of the extra man were eliminated.

Discussion

In using calcium cyanide the dangerous properties of the gas evolved should be constantly in mind in spite of the fact that the margin of safety in the concentration of the gas used is considerable. In the Journal of Agricultural Research Vol. XI No. 9, 1917, DeOng says that

PLATE 5



Interior of dairy barn fumigated for house flies.

the concentration of hydrocyanic acid gas necessary to kill houseflies 100% effectively with an exposure of one hour, is .0046%. This is 4.6 parts per 100,000 of air. Various percentages of the flies were killed with lower concentrations of the gas.

The toxicity of HCN depends chiefly upon two factors: concentration and length of exposure. When liquid hydrocyanic acid gas or HCN generated from sodium cyanide by means of sulfuric acid and water is used, the initial concentration is high. With calcium cyanide these high concentrations are not reached due to the slow evolution. Theoretically, calcium cyanide at a rate of 1 lb. per 1000 cubic feet of air space should produce a concentration of 300 parts per 100,000.

It has been shown by actual experimentation that less than ⅓ of this amount is present in the air at any one time when this dosage is applied as a film on the floor. On this basis, the concentration from the house fly dosage—½ oz. per 1000 cubic feet—would not be more than 3.1 parts per 100,000 at any one time, at least near the floor, and would be less than that during most of the fumigation. The concentration near the ceiling and in the dust cloud itself was undoubtedly higher, as the flies were killed, but even here the margin of safety to man would be great.

Due to its great properties of diffusion, HCN soon becomes dissipated even in comparatively tight buildings. It was largely due to this reason that HCN was not successful as a war gas. The danger due to the presence of gas in rooms fumigated at the low dosages recommended at the time of airing out would be very slight.

Since the concentration of the gas near the floor is never high except for a very brief time, this increased the margin of safety still more.

In the Journal of Hygiene Vol. XXI No. 3, May 1923, Liston & Goré state: ". . . . it is difficult to obtain a sufficient concentration of the gas in the open air to poison men. It is pointed out that this experience accorded with that obtained during the war when hydrocyanic acid gas was used as a poison gas. It was stated that men are comparatively less susceptible to the poison than animals. Birds, for example, are very susceptible. Among mammals, dogs are killed in half an hour when exposed to about 8 parts of gas in 100,000 parts of air; cats require 12 parts; rabbits, 15 parts; rats, 20 parts to kill them; while goats and monkeys require nearly 25 parts. A man requires at least as much as a monkey to kill him." According to this it then requires several times as great a concentration of the gas to kill goats, monkeys and probably man as to kill flies.

Liston and Goré further state: ". . . . In low concentrations the gas causes a very disagreeable sensation in the throat and eyes so it is avoided by persons brought in contact with it. A man becomes unconscious only when exposed to higher concentrations, and, if the concentration which just causes unconsciousness is not increased, a comparatively long latent period supervenes before death. A person who becomes unconscious when exposed to moderate concentrations of hydrocyanic acid gas recovers rapidly when placed in the open air. The gas acts much like an anaesthetic such as chloroform. However, exposures to high concentrations may cause instant death, probably through action on the heart."

If slight effects are ever felt when handling the calcium cyanide they can be counteracted by occasionally inhaling ammonia or ammonium carbonate.

In fumigating the stores six mice were killed by the one ounce dosage in one room, one in another and still another in a third room. Two mice were killed in one store with the one-half ounce dosage. One rat was killed during the tests at the laboratories. The control of rodents can be facilitated by distributing some of the dust near the places where they are or may be concealed without in any way reducing the efficiency of the housefly control. Bats were also quickly killed.

While the figures of paragraph 3 under "Discussion" are only approximations, they show that, when the ½ oz. dosage is used, the concentration of gas required for the 100% kill of flies as derived by DeOng does not occur near the floor for a very long period at least and then possibly not uniformly. The gas, however, does become concentrated in the places where flies congregate for the night and if the rooms are reasonably tight will go above the 3.1 and probably above the 4.6 parts per 100,000 of air since they are effectively killed.

A dust gun may be used in applying the dust but it is not necessary. In case a dust gun is employed it should be thoroughly cleaned each time after it is used in order to prevent corrosion.

Domestic animals were never kept in the buildings during any of the fumigations and *fumigations should never be conducted with these present.*

That the greatest kill occurred in the first half hour was shown from observations made through the windows. Where conditions are such that only a few hours are available for fumigation, exposures of two hours for large rooms should give good results.

Conclusions

1. The experiments reported indicate that at least for the conditions that prevailed at Clemson College, S. C., during the last summer, the dosage of calcium cyanide needed in housefly fumigation ranges around ½ ounce per 1000 cubic feet, being slightly less in large rooms with very little leakage when fumigating at night when the flies are in the upper parts of the rooms and more as the amount of leakage increased, the increase being greatest in the smaller rooms. During the day the flies are likely to be in lower and more protected places and an increased dosage may be necessary especially for small spaces. Very large rooms even with considerable leakage can be successfully fumigated with the ½ ounce dosage, but smaller rooms of similar structure often required the one ounce dosage and sometimes more. It is believed that a dosage will have to be derived for each situation according to size and shape of the room, the amount of leakage in the walls and perhaps other factors. The ½ ounce dosage should prove a good basis for the first estimate with conditions similar to those in these experiments.

2. The margin of safety seems to be very great both from the practical and from the theoretical standpoint. Dosages higher than one ounce per 1000 cubic feet would probably never be warranted and should not be used unless further tests indicate them to be practical and economical.

3. Domestic animals should not remain in the rooms being fumigated in spite of the fact that the concentration of the gas might not constitute a lethal dosage. Canaries, however, would probably be killed while dogs which are very susceptible to HCN also might be. Rats, bats and mice were killed in the experiments.

4. Fumigations at night are usually more effective and more convenient.

5. Better results were usually secured in experiments where the cloud method of application was used rather than the film method.

6. Scattering some of the dust around places that may conceal rodents will give better kill of rats and mice and will not decrease the control of the houseflies.

7. Care should be taken in handling the calcium cyanide to prevent loss of the gas and to prevent corrosion of metal surfaces with which the dust may come in contact.

8. This method of housefly control is especially useful in large rooms such as dairy barns, stables, stores, bakeries, packing houses, store-rooms and in many other places where other methods of control are not practical and economical.

9. While preliminary tests showed that this method might be applicable to household use under certain conditions, it should not be recommended generally for this purpose. The possibilities of unfortunate circumstances arising from placing the material in the hands of people unacquainted with the nature and use of poisonous insecticides is far too great to warrant its recommendations for this use.

MR. PEREZ SIMMONS: Are there any advantages in scattering the dust through the air to spreading it on the floor?

MR. C. O. EDDY: We seemed to get more effective control from using the dust. I don't know what all the factors involved are, but possibly there is more gas involved. Anyhow in the comparison of the different experiments we got better results from those.

MR. PEREZ SIMMONS: In using it in restaurants, wouldn't it upset the whole place?

MR. C. O. EDDY: In restaurants we usually do use it as a film on papers on the floor.

MR. G. A. DEAN: The Dairy Husbandry Department of the Kansas State Agricultural College has been practicing for some two months by using the dust in their big milk house. They simply close the building up tightly just a few minutes before they are ready to bring the animals in and start down at one end with the dust gun and go clear through to the other end. Then they bring in the milch cows. They don't sweep up the dust or anything. There is no inconvenience to any of the animals. The flies do not bother the animals.

Another interesting thing that developed there is that after they have opened the house and are in there milking the cows, the flies lighting on the walls and around are still being killed. I just suggest that there is an adsorption of gas by the plaster there, or by the wood, that is still killing flies after the place has been opened.

MR. C. O. EDDY: There is one thing I did not mention and that is in the fumigation in the dairy barn the cost was reduced by one-fifth or one-sixth in comparison to the use of pyrethrum which was used prior to the starting of these experiments, and so the dairy barns began to use the calcium cyanide entirely in place of the pyrethrum and did away with the use of the dust gun. We found it was not necessary, although it is perfectly all right to use it.

MR. C. A. WEIGEL: How long a barn was it?

MR. C. O. EDDY: About 60 feet long, I would say, and some 25 feet high.

MR. C. A. WEIGEL: Did you try it out on windy nights?

MR. C. O. EDDY: Yes, and especially in small buildings we had considerable difficulty; we had to increase our dust quite a little bit.

MR. PEREZ SIMMONS: Did you succeed in killing cockroaches in the restuarants with the one-half ounce per thousand cubic feet?

MR. C. O. EDDY: I don't know about cockroaches but I do know we killed mice, rats, dragon flies and bats.

MR. C. C. HAMILTON: In connection with some of the investigations going on in New Jersey, through one of the fellowships established by the Crop Protection Institute, I might say that the Walker Gordon Dairies have used the pyrethrum extract with kerosene and they feel it is commercially profitable to them to control flies in the dairy barn. They have three large establishments—one near New Brunswick, one in central New Jersey and one in Connecticut, I think. They feel it is of value to them. The work was done by Mr. Nelson and he has a very large amount of data, but unfortunately hasn't been able to present it.

MR. H. N. WORTHLEY: I should like to ask Mr. Eddy if he thinks treatment of dairy barns for houseflies will supplant or render unnecessary treatment of breeding places.

MR. C. O. EDDY: I discussed that point in the introduction of my paper. The treatment of breeding places is always necessary and will always be and should be given preference. We found at Clemson College this summer that the houseflies could not be cleaned up from that standpoint, and this method was adopted by the dairy farms and restaurants to take care of a nuisance that was not being taken care of otherwise.

PRESIDENT ARTHUR GIBSON: The next paper is by R. W. Leiby.

"COLD STEAM" SPRAYING MACHINES

By R. W. LEIBY, *Department of Agriculture, Raleigh, N. C.*

ABSTRACT

Orchard and field crop sprayers that break up a spraying liquid by steam generated in a steam boiler are described A five H. P. boiler generates steam with a gasoline burner as the heat source. From 80 to 100 lbs of steam pressure will break up a spraying liquid to the fineness of steam itself at the nozzle, the steam passing through a separate lead of hose and meeting the spraying liquid at the nozzle. Any degree of fineness or coarseness of the spray can be secured by regulating the amount of steam allowed to pass through the nozzle.

Ever since we have been using spraying machines to treat crops for insects and diseases we have been practically depending upon the single principle of forcing a liquid under pressure of from 60 to 400 pounds through a small aperture to produce a spray. Another principle—that

of breaking up a liquid by heat and the velocity of steam is used in the Cold Steam spraying machines to finely divide a spraying liquid.

With this principle in mind four spraying machines have been developed in which the writer has had a field trial and a consulting part.[1] Only those that break up a spraying liquid by steam will be referred to here.

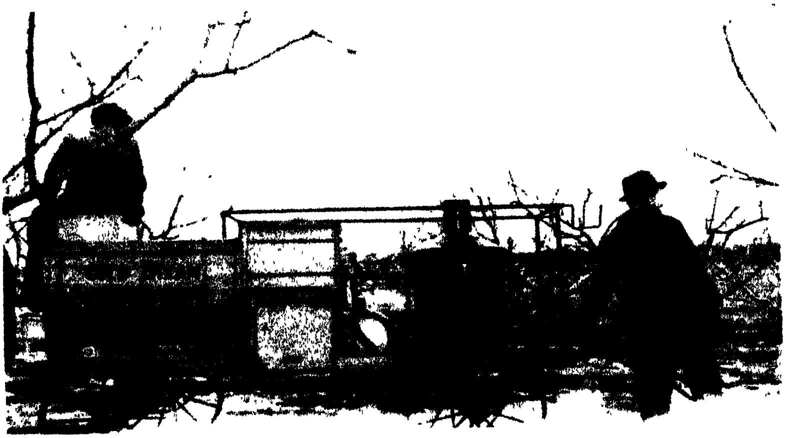
Steam Orchard Sprayer

The steam orchard sprayer used was mounted upon an ordinary spraying chassis, a steam boiler of five H. P. capacity which is operated by a gasoline or fuel oil burner generating from 60 to 150 pounds of steam pressure, supplying the steam. Spraying is done satisfactorily at from 80 to 100 pounds steam pressure. The boiler is fitted with an injector. On the chassis are also mounted a 150 gallon wooden tank to contain the spraying liquid, a 25 gallon wooden tank to carry water for the boiler, and a cylindrical metal tank to supply gasoline or fuel oil under low air pressure to the burner. A compartment between the fuel and spray tanks and under the water container, furnishes space for a steam driven agitator.

Steam is generated to operating pressure within fifteen minutes in the boiler and conducted through one lead of hose to a venturi nozzle. The spraying liquid is "pulled" to the same venturi nozzle by the steam, where it is broken up into a mist as fine as steam itself, or into a coarse wet spray,—the fineness of the spray depending upon the amount of steam that the operator permits to pass to the nozzle. If approximately one part of water, as steam, is used to break up three parts of the spraying liquid, the resulting spray will be almost as fine as steam itself. In this event, one steam nozzle does about 90% of the work of two high pressure sprayer nozzles, in time consumed and area covered. The steam sprayer has the very decided advantage of, *first*, saving spraying materials, and, *second*, applying the spray where it belongs in uniform quantities. If about three times the above relative quantity of spraying liquid is permitted to pass to the nozzle, the spray will be somewhat finer than that secured by the average sprayer operating at 250 to 300 pounds pressure. Any degree of fineness or coarseness of spray is available to the nozzle operator by opening or closing a valve which regulates the amount of steam entering the nozzle near its aperture.

The spray escapes with enough force to carry the fog-like mist considerable distances. The enveloping character of the resultant mist

[1]Patents pending by the Cold Steam Corporation, Charlottesville, Va.



Cold Steam orchard sprayer (Upper figure)
Applying the dormant spray with the steam sprayer. A five H.P. boiler will allow operation of two nozzles.

Steam sprayer of the cart type. Only steam is passing through the nozzles (Upper figure).
Applying calcium arsenate in an oil spray to cotton.

covers both sides of the leaves as a fog would do, and settles so gently that no harm is done to the bloom even at its calyx stage. The temperature of the spray at twelve inches from the nozzle is slightly below that of the atmosphere.

Slightly more gasoline is required to operate the steam boiler than to run the average gasoline engine of a high pressure sprayer. This extra operative cost is more than compensated by the following advantages, *first*, absence of moving parts, *second*, absence of pump and gasoline engine and therefore a freedom of costly and vexatious delays, *third*, lower upkeep, and, *fourth*, a decided saving in the amount of materials used. If fuel oil is employed under the boiler, the cost of fuel is less than that of gasoline used in high-pressure-sprayer gas engines.

The first cost of the Cold Steam Sprayer is at present greater than that of the average orchard high-pressure-sprayer. It would appear, however, that the steam sprayer would give longer service. Moreover the uses of steam about the farm in connection with a movable spraying tank are varied. Among them are, cleaning vessels, applying a thin film of oil or paints to farming machinery or buildings for protective purposes, whitewashing or disinfecting buildings, or cleansing motors of grease.

Field tests conducted over a period of two years including the dormant and summer sprays, have shown that insecticides and fungicides can be applied by the steam sprayer as effectively as with the high-pressure-sprayer. Moreover this is accomplished by a saving of from 30 to 40 per cent of the spraying material because the spray can be controlled so as to prevent wastage by dripping. It would appear entirely possible to uniformly distribute a definite quantity of the basic insecticides and fungicides of a given formula upon an acre of trees, in half the quantity of water or carrying liquid, now required or used to distribute the same quantity of insecticides and fungicides by means of the pressure-sprayer. This has been done in the case of a dormant spray of lime-sulphur where the dilution was only one-half that usually made for the dormant lime-sulphur spray. Less than one-half of the usual amount of spray was applied per tree at the reduced dilution but with equally good results as when the regular amount was applied by the high-pressure-sprayer at the usual dilution.

Field Crop Sprayer

The steam machine has also been adapted to the spraying of field crops, though it has been used experimentally thus far only for the spraying of cotton. In this machine a four H. P. steam boiler is mounted

on a two wheel cart. Eight nozzles properly directed will envelop cotton three feet high in a mist of the spray.

The field crop sprayer was used in an effort to control the boll weevil on cotton. It was found that five pounds of calcium arsenate could be suspended in as little as five gallons of water, and the poison applied uniformly over an acre of cotton. Treating three rows at a time, an acre of cotton can be covered in fourteen minutes. It is well known that from 100 to 150 gallons of a spraying liquid are required to cover an acre of an average row crop such as irish potatoes using a high-pressure-sprayer, especially if it is desired to cover all parts of the plants. It appears therefore that the Cold Steam Sprayer would obviate the necessity for large amounts of water now used as a carrying medium in the spraying of truck crops when applying insecticides and fungicides by a pressure-sprayer.

MR. J. M. SWAINE: What is the cost of the four horsepower machine?

MR. R. W. LEIBY: It isn't on the market yet.

MR. W. S. HOUGH: Several years ago there was a machine placed in some of the Virginia apple orchards in which the atomizing was done by air. Judging from these pictures the type of spray was very similar. It used a small amount of liquid, and made a very fine mist. These machines were so unsatisfactory in controlling the codling moth worm that they did not prove practical at all and have been abandoned.

PRESIDENT ARTHUR GIBSON: The next paper is by R. W. Doane.

THE GENUS IPS ON THE STANFORD CAMPUS

By R. W. DOANE, *Stanford University*

ABSTRACT

Twenty years ago *Ips plastographus* was the only species of *Ips* to be found in this vicinity. Ten years ago *I. radiatae* was more abundant than *I. plastographus*. Today both of these species have been supplanted by *I. confusus*.

About 1903 G. A. Coleman began a series of studies on the insect pests of the Monterey pine (*Pinus radiata*) on the Stanford Campus and at Pacific Grove. As these insects were killing many trees he had a good opportunity to make careful observations on several of the bark beetles. In this list he mentions only one species of *Ips*, *I. plastographus*. The descriptions that he gives of the work leave no doubt as to the species that he was dealing with. In 1904 P. B. Powell used some of the bark beetles in some studies he was making on the wing development of beetles. In the paper giving the results of these studies he describes

the typical work of *I. plastographus* and makes no mention of any other *Ips* work.

When I returned to Stanford in 1905 I began a series of observations on these insects and during the fall quarter of each year since then I have had occassion to continue these studies in connection with a course dealing with forest insects.

In 1905 and 1906 the only *Ips* work that I found was the work of *I. plastographus.* About 1907 we began to find in the same trees work of another species of *Ips.* This work was easily distinguished from the work of *I. plastographus* because the brood chambers were more or less curved and the eggs were deposited in the nitches along the sides in groups, three or four in a group, instead of singly as in *I. plastographus.* Specimens of both species sent to Dr. A. D. Hopkins in 1908 were identified as *Tomicus* (*Ips*) *plastographus* and *Tomicus* (*Ips*) *sp.* We later learned that Dr. Hopkins gave this undescribed species the manuscript name of *Tomicus* (*Ips*) *radiatae.*

From 1908 this undescribed species kept increasing in numbers until in 1914–15, when F. M. Trimble did his excellent piece of work on these two species, they occurred in about equal numbers in nearly all infested trees. It was at this time that Hopkins published the name of the new species, calling it *Ips radiatae.*

About 1916 *Ips radiatae* began to become the predominant species and in a few years it had almost entirely supplanted *I. plastographus* although specimens of the latter species were still found now and then.

In the fall of 1921 we found our first specimens of *Ips confusus* on the campus. These were found in a small yellow pine that had been planted near a wood yard in the nursery grounds. Previous to that time this species had not been reported from the San Francisco peninsula but we had occassionally found examples of its work on slabs of yellow pine that had been shipped into Palo Alto for fuel. The winters of 1922, '23, and '24 were exceptionally dry and many of the conifers throughout the state suffered considerably on this account. The weakened condition of the Monterey pines on the campus made them an easy prey to the bark beetles and many of our finest trees quickly succumbed to these attacks.

The swiftness with which *Ips confusus* spread over the campus was remarkable. Within two years it was the predominant species. *I. plastographus* had entirely disappeared. *I. radiatae* was still to be found in the lower part of some trees where *I. confusus* was working in the upper part. Our examinations this fall, 1926, have revealed very few

I. radiatae, while *I. confusus* is abundant in all weakened trees and is killing the tops of some of them.

Observations made on other parts of the San Francisco peninsula seem to indicate that *I. radiatae* is fast crowding out *I. plastographus* and that *I. confusus* is becoming established in some other places. It should be remembered that all of the Monterey pines outside of the Monterey peninsula and a few smaller groves along the coast are trees that have been planted for ornamental purposes.

In the native groves in the Monterey Peninsula *I. plastographus* was the only species known until about 1908 when *I. radiatae* began to appear in considerable numbers, the two species working together in the same tree apparently in defiance of Jordan's law of geographic distribution. Time has shown, however, that this is only a temporary arrangement for *I. radiatae* appears to be gradually driving out the other species. *I. confusus* has not yet found its way to the Monterey Peninsula. It will be most interesting to find what happens when it does gain a foothold there.

The only explanation that I can see for this succession of species in these pines is that *I. radiatae* is able to establish itself in a tree a little earlier than *I. plastographus* and that *I. confusus* is able to maintain itself in trees that would repel either of the other two species. None of these bark beetles seem to be able to enter a strong, thrifty tree, but when the tree becomes weakened from any cause whatever, its power of resistance is lowered and it becomes prey first to the beetle that can tolerate the strongest sap flow. As the sap flow is diminished other species may follow, and, if there is enough cambium left for them to rear their young, they too may survive, otherwise they perish.

Will *Ips confusus* finally exterminate the other species throughout their whole range?

MR. J. M. SWAINE: I would like to ask Professor Doane which species caused the outbreak in the Monterey Peninsula.

MR. R. W. DOANE: *Plastographus* has been the most common species on the Monterey Peninsula until the past four or five years. *Radiatae* is fast taking its place, although both species are still found.

PRESIDENT ARTHUR GIBSON: The next is a paper by S. B. Fracker and A. A. Granovsky.

THE CONTROL OF THE HEMLOCK SPANWORM BY AIRPLANE DUSTING

By S. B. FRACKER and A. A. GRANOVSKY, *Madison, Wisconsin*

ABSTRACT

Calcium arsenate at the rate of twenty pounds to the acre dusted from an airplane over a mixed rugged forest was successful in killing the larvae of *Ellopia fiscellaria* attacking hemlock and balsam.

In July, 1925, the superintendent of Peninsula State Park, Door County, Wisconsin, noticed that a fine stand of hemlocks was turning brown. Upon closer observation he discovered that they were being defoliated by measuring worms occurring in enormous numbers.

The writers[1] investigated the conditions on July 17 and found that the measuring worms were occurring in all the other hemlock stands in the park, as well as in other parts of the county. As they were reaching maturity at the time, any control measures during the season of 1925 were out of the question.

When the adult moths were collected, September 10, they were promptly identified by Dr. H. G. Dyar as *Ellopia fiscellaria* Guenee.

Judging from the effects of these larvae, hemlock trees when completely defoliated, die without being able to put out a new set of leaves.

The state forester estimates the loss in 1925 at 6,000,000 board feet. At one point practically no hemlocks of any age are living on an area of over ten acres while a large proportion of those over about thirty acres additional have been killed. In the remainder of the park the infestation was less severe and the defoliation slight to moderate.

DESCRIPTION OF THE AREA

The State Park infested consists of a peninsula of 3,733 acres, about 6 square miles, extending into the waters of Green Bay. Along the margin of most of the peninsula is a flat about twenty feet above the level of the Bay, varying in width from a few feet to nearly one mile. Separating the flat from the rolling plateau, which constitutes most of the park, is a rocky bluff varying in nature from a gentle slope in some sections to a vertical escarpment of more than 200 feet at other points.

[1]The authors gratefully acknowledge suggestions from Mr. B. R. Coad, Mr. J. S. Houser, Mr. T. R. Chamberlin, and Mr. O. I. Snapp, the personal counsel of Dr. S. A. Graham, and the cordial support of Commissioner E. S. Hall, Mr. C. L. Harrington, and Mr. A. E. Doolittle of the Wisconsin Conservation Commission. The authors represent the Wisconsin state department of agriculture and the Wisconsin agricultural experiment station, respectively. A more complete report of the work will be published elsewhere.

Except for 900 acres of clearings, the entire area consists of forest: hemlock, balsam, maple, elm, poplar and white and red pine and white cedar being the most important trees. A few roads have been built through the area, but these are mostly about a mile apart and the park administration has specialized on the development of trails and bridle paths. This is of particular importance when it comes to insect control work for it is entirely impractical to use land machines for spraying or dusting except for narrow strips along the few roads. The paths and trails are not wide enough for the purpose.

A more hazardous area for airplane dusting could scarcely be imagined, for it was necessary for the plane to work down into the valleys, climb out of them, dodge unusually tall trees, and dust the edge of steep bluffs.

Life History and Habits

The eggs are deposited singly or in small masses on hemlock needles and bark in the fall, mostly during the middle and later part of September, before the advance of cold weather. They are almost spherical with a round crown-like depression on one end, measuring about 0.6 mm.

In the first or middle part of June, the eggs hatch, and small pale green larvae with conspicuous dark markings begin to feed largely on hemlock and balsam foliage. The smallest larvae observed were about 3 mm. in length and 0.5 mm. in diameter. They feed from the middle of June to early in August, evidently requiring about from 1½ to 2 months of feeding, before reaching maturity.

Most of the larvae begin to pupate in the middle of August, although there is a considerable overlapping, for at the same time the half grown larvae were not uncommonly observed. The pupation period extends well into the first week of September, but the majority of the larvae pupate in the second half of August. The pupation takes place under the bark of and in crevices of hemlock trees. Only rarely pupae were found under the leaves on the ground near the trunks of the trees. The pupae are on the average 1.1 cm. long and 0.3 cm. wide. The color of pupae is light brown with speckled markings.

The moths begin to emerge in the first part of September and continue to appear until late in the month. The majority of adults emerge, however, in the middle of September, at which time the whole hemlock wood was swarming with the flying moths, especially at twilight and in the evening.

There is thus far little indication of the presence of natural enemies in adequate numbers. In September of 1925 and 1926 numerous pupae, as well as larvae have been found parasitized by a fungus, which

produced a conspicuous white mycelial growth over the pupae and larvae. Dr. R. Thaxter, on examining it, found that the fungus is "apparently the same as the chinch bug fungus *Beauveria* (*Sporotrichum*) *globuliferum* Speg." In spite of the fact that a considerable number of larvae and pupae were affected, the value of the fungus has so far been negligible, for the reason that it attacked the insects late in the season and was unable to reduce the pest sufficiently to prevent the outbreak the following year.

The writers discovered no important insect parasites.

Preliminary Tests

Forestry practices not offering any hope of an immediate protection of the hemlock stands which were threatened with total destruction, artificial measures were tried.

Preliminary experiments with a hand duster showed that the rate of 20 lbs. to the acre should give satisfactory results. Approximately this amount was used in the work of air plane dusting. As this dosage correlated with recommendations by those who had done airplane dusting over cotton and over fruit trees, that proportion was determined upon for the field control measures.

In a commercial forest the question might have arisen as to whether the cost of dusting would pay as an investment. The conservation commissioner, however, felt the responsibility of maintaining the beauty and recreational value of the park, and believed himself justified in trying to save the remaining hemlocks if at all possible. On this basis the authors recommended the use of an airplane for the work.

Airplane Employed

It was decided to secure the plane on a contract basis and bids were requested from all firms who were known to have had experience in dusting from the air.

The contract was completed with the Decatur Aircraft Company, Decatur, Illinois, at the rate of $4.00 per acre for the services of the plane only and the company secured Les. W. Smith, Springfield, Illinois, as pilot. Both pilot and mechanician had had cotton dusting experience. The plane used was owned personally by Mr. Smith and had been adapted for dusting immediately before the work was done.

The hopper occupied the entire compartment for the mechanician so that the pilot was alone in the plane during dusting. The hopper would hold about 350 pounds of calcium arsenate, but after several

trials of different amounts, ranging from 200 to 300, a load of 250 was found both safe and convenient.

Agitation was secured by a small air propeller mounted on the lower left wing, driven by the airblast from the plane propeller and geared to the agitator in the hopper.

The dust was released by pulling a lever in the cockpit which opened a door in the floor of the hopper 27″ x 4½″ (later made 7″) in size.

During the eight flights on July 13 and 14, the method of covering the area used in cotton dusting was employed. That is, the pilot flew over a strip of forest releasing the dust and then returned parallel with the white strip of arsenate he could see on the trees. It was found that adequate dosage could not be secured in this way. It took six miles of flight with the hopper open to release the 250 pounds, the first 1,750 pounds covering 405 acres (4.3 lb. per acre).

The first improvement in the plan consisted of consolidating the areas and redrawing the map to show nine dusting plots instead of twenty. These nine had definite boundaries such as cliffs, clearings, and roads, which could be quickly recognized from above and each had one or both dimensions at least 60 rods long.

A second improvement to secure better dosage was a change in the hopper. The plane had in each case returned to the landing field with at least 50 pounds of dust remaining in the hopper. An extra partition was then built to cut off the lower rear corner of the hopper and it resulted in release of the full load.

As a third improvement, the opening thru which the hopper discharged was enlarged from 4½ to 7 inches in width. By keeping it wide open to this extent while the plane was discharging, the dust was released in four miles of flight instead of six as before. Finer distribution also resulted, as a larger quantity of dust struck the ventura and the under side of the plane and broke into a finer cloud than before.

Sixty-three flights were made, each load being 250 pounds, except in the first eight flights, on which 200 to 300 were tried, and the last three, when 275 were carried.

Each round trip, including loading, occupied about fourteen minutes, at times as many as five loads (1250 lbs.) being distributed over sixty acres of forest in one hour.

Taking the work as a whole, it may be of interest to note that the plane flew 252 miles of active dusting, about 100 miles while turning around after each strip, and over 500 miles from and to the loading field.

The material employed was in the main, Corona calcium arsenate, a total of 14,500 pounds without dilution with a carrier. In one section, 1,000 pounds of Niagara calcium arsenate was used.

Observations

The dust distribution could be very readily determined on almost any deciduous leaves, as well as hemlock needles. When evenly distributed at twenty pounds to the acre, it could be seen at a glance on the leaves of such trees as basswood, oak, beech, and maple and such undergrowth as dogwood, wild currant, fern and wild strawberry.

The number of dust particles per hemlock needle was of special interest. Accordingly, an effort was made to determine the distribution of dust on hemlock foliage. Naturally, it varied considerably, ranging from 0 to as many as 20 per one needle. Most of the needles had from one to six particles per needle.

It is of interest to note that the dust particles did not adhere well to the deciduous foliage. Upon shaking or even touching the leaves many particles fall off the foliage. Evidently there was lacking any electrical attraction between the foliage and the dust particles.

The swirling motion noted so often in connection with cotton fields is probably due to the interaction of the propeller blast, the ground, and the cotton plants. In the case of forest work, the ground is not near enough to cause air eddies in this way and there was no tendency for the dust to attach to the under sides of the leaves. It descended in about 20 seconds, straight down on calm days, and diagonally when there was a slight wind. An 8 mile breeze did not interfere with the work, but 10 miles per hour caused too much drift.

Larvae Died Within 24 to 48 Hours

In order to determine the mortality of worms in the forest after the airplane dusting several methods were used.

When twigs are lightly shaken, the larvae invariably hang on silken threads and their number on a given twig can easily be detemined by comparison with similar twigs in dusted areas, or before and after dusting. The following table will illustrate the use of this method in showing the efficiency of dusting the solid hemlock in the first plot covered; the 40-acre stand at Shanty Bay.

TABLE 4. INFESTATION BEFORE AND SIX DAYS AFTER THE DUSTING

No. of twig	Description of twigs	Number of living worms Before dusting	After dusting
1	Twig 3 feet long	19	0
2	2 twigs 2 feet long	27	1
3	Twig 1½ feet long	11	0
4	Twig 2½ feet long	13	0
5	Twig 1 foot long	10	0
6	Twig 1 foot long	7	0
7	Twig 3 feet long	23	2
8	Twig 2 feet long	14	0
9	Twig 2 feet long	18	0

A better method for the determination of the mortality of the larvae was the use of square-yard pieces of muslin. Many such pieces of cloth were gently placed three days before dusting on the ground under hemlock trees of different sizes and in different densities of forest to determine the mortality before, if any, and after dusting. The height of the trees was recorded in order to estimate the relative area from which the larvae fell on the muslin. Approximately the same size twigs in the vicinity of these stations were shaken to determine the infestation before dusting. These stations were visited daily three days before, during and five days or later after dusting. No dead worms were found in a single instance before dusting. The worms continued to die for 5 to 8 days, but most of the larvae died between 24 and 72 hours after the dusting. The following representative table shows the death rate of larvae at "Hemlock Ridge," which was dusted July 17, 1926.

TABLE 5. MORTALITY OF LARVAE AFTER DUSTING

Number of larvae found on cloth after dusting

No. of station	July 18 D.	L.	July 19 D.	L.	July 20 D.	L.	July 21 D.	L.	July 23 D.	L.	July 24 D.	L.	July 25 D.	L.	Surviving on twig
1	52	1	33	0	—	—	Cloth disturbed and moved away about 25 ft. on July 20								
2	72	1	—	—	—	—	Cloth disappeared on July 19								
3	11	1	—	—	8	0	Closed on July 20								
4	15	0	—	—	11	0	2	0	2	1	2	0	1	3	3
5	33	0	34	0	28	0	2	0	Disturbed by animal. Closed July 23.						
6	12	0	26	2	33	0	Closed on July 20.								
7	9	1	6	0	8	1	Closed on July 20.								
8	1	1	5	1	3	0	5	0	0	0	1	0	0	0	3

As indicated, some trouble was experienced from animals in the woods which often disturbed the pieces of muslin at night.

From this table it is evident that in some instances as many as 97, 85, 73, 72, etc., dead larvae fell on the ground per square yard.

It is estimated that in a solid hemlock stand the mortality was 90 to 95%, while in the mixed forest not less than 80%. In only one area which consisted of young hemlocks over-topped by deciduous trees, and another which was dusted just before a rain, were the apparent results somewhat less than expected, with a mortality about 60%.

Cost

The contract called for a payment of $4.00 per acre by the Wisconsin Conservation Commission to the Decatur Aircraft Company, the Commission to furnish (a) the dust, (b) assistance in loading, (c) full instructions as to boundaries of the areas to be dusted, (d) a landing field. Fortunately a rental expense for the field was unnecessary, as it was offered by the owner for the purpose.

All areas dusted a second time were paid for at the same rate. The initial experimental flights thus proved expensive.

The commission informs the authors that including the preliminary flights the total cost was as follows:

Decatur Aircraft Company	$3,860.00
Corona Calsenate	957.60
Niagara Calcium arsenate	74.55
Freight and dray	112.90
Labor (approximately)	30.00
Total	$5,035.05

This shows an average total cost of $7.04 per acre for labor and material for the 715 different acres covered at full dosage. This amount is considered very moderate when compared either with the value of the trees saved, or with the cost of dusting from land machines.

Summary

The hemlock spanworm, *Ellopia fiscellaria*, while rarely reported as of economic importance, is able to destroy coniferous forests completely.

In the Wisconsin outbreak, hemlock and balsam suffered severely, and after they were defoliated the spanworms would feed freely on other trees. A single defoliation is fatal to hemlocks.

This species hibernates as an egg which hatches in June. Feeding continues until the middle of August or later, and pupation occupies about two weeks. The adults fly, mate, and oviposit in late September.

Airplane dusting proved a successful method of control and was used for 715 acres of infested forest. The area was extremely rugged and offered many difficulties and dangers.

Calcium arsenate dust, without dilution, at the rate of 20 pounds to the acre, gave an apparent mortality of 60 to 95 per cent.

An opening of 7 x 27 inches in the hopper was necessary in order to release the dust at the rate of 250 pounds in 4 miles. This covered a strip 1½ rods wide with satisfactory distribution.

Of various methods of determining distribution, observation of the dust on the leaves of deciduous trees, especially maple and dogwood, were most satisfactory.

Per cent of mortality was obtained (a) by comparison of branches before and after dusting, and (b) by catching dying and dead larvae on squares of convass left below the infested trees. The simplest form of check is a daily comparison of the dusted with the undusted areas as the work progresses.

No indication of electrification or other unusual adhesive qualities was obtained, and the arsenate did not reach the under sides of the leaves.

Mr. D. F. BARNES: I would like to know what the depth of the ventura section was beneath the hopper.

Mr. S. B. FRACKER: As I recall it, it was three inches. The details are shown in the paper.

Mr. D. F. BARNES: You used about four pounds to the acre when flying over the area once?

Mr. S. B. FRACKER: I didn't mean to give that impression. The pilot followed the method previously used in cotton dusting. He left too wide strips between the strips of dust. In cotton it seems the dust falls and then spreads out underneath the plants as a result of air currents. In the forest that does not occur. The dust fell directly and occupied a strip of from thirty to fifty feet wide.

The result was that when he, using his cotton dusting experience, came back parallel with his former strip, his strips were so far apart that he did not apply a sufficient amount of dust. The rate of four pounds to the acre also resulted when the hopper opening was four and a half inches wide instead of seven and a half. Then he was releasing his 250 pounds in six miles of flight. We reduced the strips to about twenty-five feet.

Going underneath sixty-foot trees where the dust had been applied at the rate of 20 pounds to the acre, you could see down on the foliage near the ground an adequate supply of dust at every step.

Mr. D. F. BARNES: In our work on Cape Cod we secured the same excellent coverage. After the dust cloud was caught by the tree tops it settled in a perfect fog covering everything in sight, and the coating

was very uniform from the top to the bottom of an individual tree.

Mr. H. T. FERNALD: I think in the past we have had more or less the general impression that a single complete defoliation of an evergreen tree would result in its death. May I ask if you got any evidence on that point from the defoliation of these hemlock trees?

Mr. S. B. FRACKER: That was our conclusion, that the trees which were completely defoliated did not come back. Where they were possibly 90 or 95% defoliated, there seemed to be some return, although the growth was retarded very greatly. Where the dusting was a little late this past summer in the most heavily infested areas, the trees were showing buds this fall as if they were going to come out very satisfactorily in the spring.

Mr. D. F. BARNES: This year we had very serious defoliation on Cape Cod by the gipsy moth. In many places the pitch pines (*Pinus rigida*) were completely defoliated. When these areas were visited in September many of the pines had a new suit of foliage so that it was difficult to tell those that had been defoliated from those that had not been damaged.

ADJOURNMENT: 12:05 p. m.

Friday Afternoon Session, December 31, 1926, 1:40

PRESIDENT ARTHUR GIBSON: The first paper on the program this afternoon is by W. P. Flint and C. C. Compton.

Mr. Flint read the paper.

A SUGGESTION FOR CONTROLLING THE LOCUST BORER, *CYLLENE ROBINIAE*

By C. C. COMPTON and W. P. FLINT, *Illinois Natural History Survey*

ABSTRACT

The Black Locust is one of the most valuable of the native trees growing in the United States. Many locust plantations have been started in Illinois, but practically all of them have been destroyed by the Locust Borer, *Cyllene robiniae* Forst., in most cases before the trees became of sufficient size to be used even for posts. During the past ten years, many experiments have been conducted to try and find a control for the Locust Borer. These have included most of the recommended practices, and many others. Experiments in poisoning the beetles were carried on for several years, at first with promising results, but in the other years, the results were largely negative. It is shown in the course of this work, that many of the female Locust Borers emerge from the tree, mate, and lay considerable numbers of eggs without having fed.

Banding the trees with various materials, particularly tanglefoot showed that the active beetles readily caught in the bands were not killed, and soon freed themselves of most of the tanglefoot.

During the past year, bands containing tanglefoot mixed with sodium fluoride and sodium arsenite have killed all beetles coming in contact with them. The

sodium arsenite-tanglefoot mixture, seems to offer promise of a practical method of Locust Borer control under certain conditions.

Sound Black Locust is generally considered our second best tree for fence posts in Illinois. The value of this tree has been recognized for a number of years and a score or more enterprising men in the State have in the past set out Black Locust plantations ranging in size from one to sixty acres. In nearly every one of these plantations, it would now be impossible to find more than a few sound posts in the lot. This is because of the ravages of the Locust Borer, *Cyllene robiniae*. In some of the worst infested plantations the trees have been entirely killed out with the exception of an annual growth of suckers from the trunk of the tree.

The results in these plantations in the northern and central parts of the State indicated that if we can not control the Locust Borer, we can not grow sound posts or, in most cases, any posts at all. Many sprays which have been tried as larvicides, or ovicides, have not proved successful and the problem seemed one of controlling the insect in the adult stage.

With the idea of poisoning the beetles, various baits were tried out during their active period in 1922. The temperature during this period was above normal and the weather clear and dry. It is in this kind of weather that the beetles are most active. Under these conditions it was found that the beetles fed quite readily on strips of fermented watermelon and cantaloupe rind which had been poisoned with calcium arsenate or arsenate of lead. It was also found that a bait composed of molasses, spoiled plums, bananas, and a little water which had been allowed to ferment was very attractive to the beetles. When this latter bait was poisoned with calcium arsenate a large number of beetles were killed. The addition of such materials as ethyl butrate, amyl acetate, anise and many others, did not add to the attractiveness of the bait.

The following year, 1923, these baits were tried out again and this time on a larger scale. However, the weather conditions were just the opposite those of 1922. The temperature was below normal and rain fell most of the time. Under these conditions the beetles were less active and were not attracted to the baits to any great extent. For this reason, baits did not seem promising. It was also found in cage experiments that it required three days to get a complete kill of the beetles with calcium arsenate, six days with lead arsenate, while the beetles lived twelve days in the check cages. The inefficiency of the poison baits was further demonstrated by the fact that the beetles were still able to lay eggs after feeding on the poison bait. When lead arsenate

was used the female beetles laid an average of 23 eggs over a period of three days. When calcium arsenate or sodium arsenite was used they laid an average of 17 and 21 eggs per female respectively on the first day and none thereafter. In check cages when unpoisoned bait was used the beetles laid an average of 88 eggs over a period of seven days.

In the course of this work, it was observed that the female beetles often emerged from its burrow, mated and laid eggs without leaving the tree for food. An experiment was run to further prove this point. The beetles used in this work were chopped out of the pupal cells in the tree. One female and two males were used in each cage and the number of eggs laid daily recorded. The average number of eggs laid by these beetles was 42.5. In every case the beetles laid the greater part of their eggs during the first two or three days that they were confined in the cage and none were laid after six days. This shows that the beetles are capable of laying eggs without feeding. Normally after laying the first lot of eggs they fly to the goldenrod and remain there to feed for a period of two or three days before returning to the trees to deposit eggs. How many times this operation is repeated we are unable to say.

The activity of the beetles and their habit of running up and down the trunk of the tree led us to believe that tanglefoot might be effective as a means of control. In the early work with tanglefoot it was found that altho the beetles did not avoid the tanglefoot and became smeared with it they were able, in most cases, to clean themselves, and were not killed. The idea of incorporating a poison in the tanglefoot so that in cleaning up the beetles would be poisoned was then tried. During the season of 1926, a series of experiments was carried out to determine the possible value of such a material. Arsenate of lead and calcium arsenate did not mix well with the tanglefoot. Sodium fluoride made a very good union with the tanglefoot but the poison worked too slowly on the beetle. However, a 50% solution of sodium arsenite unites excellently with tanglefoot, does not injure its sticking qualities and gives a quick kill of the beetles. The sodium arsenite, tanglefoot mixture irritates the feet of the beetle and they will proceed to clean themselves almost immediately upon coming in contact with it. In cage experiments the average life of the beetles was 15.1 hours when a mixture of one part of the 50% sodium arsenite solution was used in ten parts of commercial tanglefoot and 4.8 hours when the mixture was 1–5. The average life of the beetles was 7.4 days when straight tanglefoot was used, and 11.9 days when no tanglefoot was used. When used on trees

in the open, it was found that very few beetles escaped the poison tanglefoot band when placed around the tree at a point approximately five feet above the ground.

It was further demonstrated that the sodium arsenite mixture at the 1–5 strength affected the beetles in 20 to 30 minutes after they came in contact with it. In no case were any eggs laid in cages where this mixture was used. When the sodium arsenite-tanglefoot mixture was used at the rate of 1–10, a single egg was laid in one cage. When sodium fluoride was used at the rate of one part of sodium fluoride to ten parts of commercial tanglefoot the average number of eggs laid by each female was 4.3, when twice this amount of sodium floride was used the average was 1.7, when straight tanglefoot was used the average was 5.6 and when no tanglefoot was used, the average was 21.6. The beetles used in this experiment had been out and laying eggs a week or more before they were captured.

The comparatively short period of activity of the adult Locust Borer affords little time for experimentation in any one year. Much more work must be done before any definite recommendations can be made. However, it is felt that the sodium arsenite-tanglefoot mixture may prove of value, on this and possibly some other insects at least under certain conditions, and will certainly warrant further tests being made.

Mr. H. B. Pierson: Did you state that when beetles come out they lay their eggs in the same tree?

Mr. W. P. Flint: Not necessarily in the same tree, but as a rule they lay a certain number of eggs before they feed.

Mr. H. B. Pierson: Would the tanglefoot get those beetles?

Mr. W. P. Flint: We don't claim it would get all of them, but when they come out they run around over the tree for a certain length of time before they begin laying.

Mr. H. B. Pierson: In what part of the tree are they laid?

Mr. W. P. Flint: All up and down the tree, stuck into little crevices, deposited singly.

President Arthur Gibson: The next paper is by J. S. Houser.

ELLOPIA ATHASARIA WALK., A LOOPER ATTACKING HEMLOCK[1]

By J. S. HOUSER

ABSTRACT

This Geometrid looper appeared in hordes in 1925, attacking hemlock in eastern Ohio. A few other forest trees were injured. Defoliation killed hundreds of hemlocks—some large enough for saw logs. Scourge disappeared, 1926, probably as a result of the work of the fungus *S. globuliferum* attacking the over-wintering pupae.

September 14, 1925, the writer observed that the hemlock in the vicinity of East Liverpool, Ohio, was dying in great numbers. In this section of the state hemlock occurs as a mixed stand with beech, maple, oak, elm, etc., in some areas occasionally amounting to forty per cent of the stand while in still more restricted sections the stand is almost pure. The larger trees reach saw-log proportions and the species is considered one of the valuable trees of the area, not only from the utilitarian standpoint but from the easthetic as well. In the latter sense it is prized especially since it is the only conifer commonly found, and thus contributes much to the beauty of the landscape, particularly during the winter months. The dead and dying trees, even in the distance, were very apparent as one drove along but when a critical examination was made of roadside trees the cause of the trouble was not so easy to determine since the larvae, which at that time were abundant, present a most excellent example of protective resemblance and coloration. Hemlock was the chief host but red oak, white oak, beech, soft maple, and ironwood were found also to be injured to a slight degree.

The concensus of opinion of farmers and others seemed to be that the hemlock had been ailing for two or three years but no one with whom I talked had ever observed feeding larvae. Most seemed to think that a disease, such as chestnut blight, or perhaps some obscure scale insect, was responsible for the trouble and that the hemlock, like the chestnut, was doomed, as indeed it seemed at that time to be. The older residents could not recall a time previously when hemlock had not been healthy in that vicinity but one man remembered that some fifteen or twenty years ago practically all the hemlock in an area south of Wheeling in West Virginia had died. In passing it may be well to note that in northern Michigan and in a restricted section of Wisconsin similar injury to hemlock has been reported recently but a different species, *Ellopia fiscelleria* Gn., is the causative agent.

[1]Determined by Dr. Carl Heinrich.

Athasaria in the larval stage is typical of the Geometrids in form and manner of locomotion. When mature the larva is about 30 mm. long and 3 mm. broad. It is almost cylindrical though the cephalic end is slightly narrower. In color it very closely resembles a hemlock twig. Since the writer has been unable to find a description of the larva one is appended hereto.

LARVA. 30 mm. long, 3 to 4 mm. broad, cylindrical and slightly narrowed toward the cephalic end. Head distinctly bi-lobed, the ground color light pearl but this is almost obscured by many irregularly sized brown spots, the larger of which are so very dark brown they are almost black. Thoracic legs and the legs borne on the sixth abdominal segment are honey yellow and the anal legs or claspers are greenish-yellow, abundantly dotted with irregularly shaped dirty-brown marks. The spiracles are jet black. Beneath, the caterpillar is very pale greenish-white marked by five broken, rather wavy narrow brown lines extending from the third pair of thoracic legs to the first pair of abdominal legs. At the outside of the anal margin of each abdominal segment is an obscure lemon yellow spot. The sides of the body are much darker, the color being due to wavy lines, some very narrow, others broader, the predominating colors being very dark brown and reddish brown with now and then a touch of white. The dorsum is much lighter in color, each segment prettily marked by indistinctly designated yellowish and light brown areas intermingled with more distinct white and yellow areas.

The caterpillars start their work in the tops of the trees and gradually extend the injury downward, finally reaching the bottom. Some needles are consumed, others cut off and since the insects spin some silk the cut needles collect therein, and the tree gradually assumes a very untidy appearance. The top of the tree dies first and as defoliation continues the lower branches sucumb. One complete defoliation kills the tree. Soon bark beetles and other insects invade the wood and unless cut within a few months the tree is a total loss.

In so far as is known there is but one brood per season, the caterpillars reaching maturity about mid September. The winter is spent in the pupal stage above the soil amid the debris of the forest floor in the shelter of fallen twigs, crevices in the base of trees, etc. Dry rather than moist situations are chosen. Contrasted with *fiscelleria* the hibernation of this species is different since the former, according to Prof. R. H. Pettit, passes the winter in the egg stage on the needles of the host. The light-brown dark-mottled pupae which vary in length from eleven to fourteen mm. are unprotected in so far as a cocoon is concerned and are only slightly secured among the debris by scattering silken threads tangled in two sharp curved spines at the anal tip.

As to control, it is a pleasure to record that artificial measures were unnecessary, since the outbreak terminated this season as suddenly as

it had appeared. Careful searching in September of this year in the areas where the larvae could be collected by the thousand last season resulted in the finding of only two larvae. In so far as could be determined, the fungus *Sporotrichum globuliferum* brought this about since in early spring the mycelium covered pupae could be found by the hundred, and no parasites were reared from the mass of material collected for observation.

By way of conclusion we might ask, just what were the contributing conditions which enabled an obscure native insect to suddenly assume the proportions of a scourge, but that would take us into a field which we as entomologists have failed to develop and until we secure more fundamental information concerning the underlying principles of insect activities such a discussion would have little actual value. We can, however, draw the lesson that every bug which feeds on any plant or animal of value has in it potential possibilities for destruction and no matter how insignificant it may seem at one time it is to be regarded with suspicion.

President Arthur Gibson: Mr. R. T. Webber will now read a paper.

SOME IMPORTANT ECONOMIC INSECTS OF CENTRAL EUROPE

By R. T. Webber, *U. S. Bureau of Entomology, Melrose Highlands, Mass.*

Abstract

Remarks on several insects of economic importance observed in the forests of Central Europe.

The recent agitation against one of the Federal Horticultural Board quarantine regulations[1] concerning the importation of certain plants into the United States to prevent the introduction of insect pests indicated clearly that doubt existed in the minds of many people as to the necessity of such rigid restrictions. While it is undoubtedly true that the facts warranted the ruling, the objections raised are not at all surprising, because most people pay little attention to insect pests unless they experience loss or see excessive damage. Printed matter or hearsay evidence is not convincing. Few of the multitude of Americans visiting foreign countries each year ever witness the havoc wrought by certain insects which at the present time have not reached our shores. Those who have done so will very likely share the views held by those responsible for our crop protection.

[1]Narcissus bulb quarantine order No. 62, Federal Horticultural Board, U. S. D. A.

The writer, having been detailed by Mr. A. F. Burgess in charge of Moth Work, Bureau of Entomology, to make in foreign countries investigations on the gipsy moth, has had occasionally an opportunity to observe some of the more common insects of the European forest.

To the men engaged in the European Investigations of the gipsy moth (*Porthetria dispar* L.) there is scarcely anything more discouraging than the failure to locate suitable infestations for parasite work. Frequently, even when supplied with apparently the best information, the trail ends in some obscure forest where no gipsy moths are present. Unfortunate as we consider ourselves at such times, there is, usually, certain recompense because some interesting insect is concerned.

While scouting in the northwestern part of Poland for gipsy moth infestations the writer first saw the effect of one of the most destructive of all forest insects, the Pine Moth (*Panolis griseovariegata* Goeze). This insect is a great devastator, and there seems to be ample proof that two years of successive defoliation will kill the trees. The reports which have reached America concerning the seriousness of its depredations are not exaggerated. In fact I know of few other insects which can be held solely responsible for the killing of forests. Usually there is a combination of insects or insects together with some other factor, perhaps natural or perhaps a condition brought about by man.

During my trip we passed through many acres of what had been a most beautiful forest of *Pinus sylvestris*. The rich sandy loam, in most part free of undergrowth, gave rise to tall stately trees 60 to 80 feet in height. Hundreds of these now stood apparently lifeless, destitute of foliage, or, what appeared even worse, crowned with remnants of weakened needles. Such was the condition of the forest in the ravaged area. This was in 1925, the infestation having reached its height in the previous year, after a two or three years' invasion. The area infested by *Panolis* in northwestern Poland was more than 50,000 acres.

An infestation of this species was reported by Summers[2] in 1913 as occurring near Eberswalde, Germany. Nearly 15,000 acres were completely defoliated and a large percentage of it killed.

There is also very good reason for believing that this is the insect reported by Hyslop[3] as devastating enormous tracts in East Prussia during 1923–24.

I have no first-hand information concerning the natural enemies of *P. griseovariegata*, but I know that some studies were made by Prof.

[2]Unpublished Gipsy Moth Laboratory Records.
[3]Insect Pest Survey Bul. 4, pp. 247, 287, 320. 1924.

Mokshetsky[4] who is soon to publish them. Baer[5] lists 11 species of Tachinid flies and Ruschka and Fulmek[6] 6 species of Hymenoptera as having been bred from *P. griseovariegata*.

As far as I was able to learn no artificial control was practised. I know that there was no spraying, and I saw no banded trees. The invasion was said to have been brought to a close by an epidemic of fungus (*Entomophthoreae*) which, according to several observers, destroyed most of the caterpillars within a few days.

The life history of *Panolis griseovariegata* Goeze, which has been given me by Dr. Stefan Keler,[7] is as follows: Adults are in the field from the end of March to the middle of April. The eggs are deposited in rows on the under side of the needles, the larvae hatching in about two weeks. The larval period extends to about August 1st, when the fully developed larvae burrow a few inches into the ground and pupate. There is but one generation, the species passing the winter as pupa. The food plants are given as various species of pine and fir.

In this same forest there was also a large infestation of the Pine Shoot Moth (*Evetria buoliana* Schiff.). In most part its attack seemed confined to the plantations of smaller growth, containing trees of about 20 to 30 feet in height, although occasionally the older trees were infested. In one plantation of several acres every tree examined had the deformed terminals characteristic of the injury caused by *buoliana*. This insect, although of much lesser importance than *Panolis griseovariegata*, rarely if ever causing the death of a tree, must be regarded as a noxious one. This is particularly true in the present case, where the forest is already filled with a growth weakened by another cause. No control measures were used against this insect.

In the same forest adults of the nun moth (*Lymantria monacha* Linn.) were occasionally found. At times this moth is very injurious to both coniferous and deciduous growths. Few insects have a more unenviable reputation than this one, and much has been written regarding its depredations. A good many of the entomologists and foresters with whom I have talked consider it the most destructive pest of the forest. In Europe the enormous losses of timber and expenditures for control are greater with this insect than with any other. I have passed through

[4]Zaklad Ochrony Lasu i Entomologji, Skierniewice, Palac, Poland.

[5]Die Tachinen, Schmarotzer der Schädlichen Insekten, p. 182 Verlagsbuchhandlung, Paul Parey, Berlin 1921.

[6]Zeitschrift für angewandte Entomologie, vol. 2, part 2, p. 407, Aug. 1915. Verlagsbuchhandlung Paul Parey, Berlin.

[7]State Institute of Scientific Agriculture, Bydgoszcz, Poland.

many forests where this insect had been rampant at previous times, but I have never happened to be present during an invasion.

Mr. Crossman, whom I assisted in 1923–24, has told me of a heavy infestation of the nun moth that he witnessed in the vicinity of Zittau and Obersdorf, Germany. The forests throughout this section are mostly pine (*Pinus excelsa* and *P. sylvestris*), there being also considerable birch and beech (*Betula alba* and *Fagus* sp.). The injury to the pine, especially the *P. excelsa*, was such that the major portion of it had to be cut the following winter. The deciduous growth did not suffer so severely. According to reliable authorities the infestation began in 1907, but did not reach alarming proportions until 1921 when the infestation was augmented by a great flight of moths from the east.

During Mr. Crossman's visit, which was in July, 1922, the insects were at their worst and acre after acre of the forest stood defoliated. Enormous numbers of caterpillars were crawling on and beneath the trees, and under certain trees lay thousands of them, dying from starvation. There seemed very little likelihood of a severe infestation for 1923.

The only method of control practised during the outbreak was by the use of "raupenleim," a somewhat sticky tree-banding material. Because of the huge area infested and the lack of necessary funds, only a portion of the forest was banded. The trees that had received this treatment were saved as nearly all of the eggs were deposited low down on the tree trunks—in many instances close to the ground.

Studies were made of the outbreak, by government men, but I do not know of their publication. Of the natural enemies of the nun moth the tachinid *Parasetigena segregata* Rond. and the Hymenopteron *Apanteles fulvipes* (Hal.) were found very frequently in 1921. The parasitism by these species in 1922 was negligible. According to Baer,[8] at least 12 Tachinids and 10 Sarcophagids are reported to have been bred from this host. There is also a list of 15 Hymenopterous parasites bred by Ruschka & Fulmek.[9]

The life history of the nun moth, which has been given me by various authorities in Europe, is as follows: The adults deposit their eggs on the bark of the tree, preferably the trunk, in July and August. Hibernation is in the egg stage, the larvae hatching about April 1st. Sometime in June and July they reach their full larval development and pupate above the ground. The pupal stage lasts about two weeks. The principal foods of the larvae are spruce and pine although oak, beech, and other deciduous plants are acceptable.

[8]loc. cit., p. 179. [9]loc. cit., p. 407.

Before leaving this locality we were advised of a *dispar* infestation at Smogulec, near Bydgoszcz. We visited this town later, only to find that the so-called *dispar* were in reality the Satin Moth (*Stilpnotia salicis* L.). The infestation was confined to the roadside trees (*Populus pyramidalis*). These trees, large and healthy, which had been stripped several weeks previously, were again in full foliage when we arrived, and apparently were in good condition.

Several other small infestations of the Satin moth have been observed in other localities but none of them seem to have caused any serious injury. In no instance have I heard of any control methods being used to combat *Stilpnotia*.

About the middle of May, 1923, Mr. Crossman and I were in Hungary. The gipsy moth season was rapidly approaching and there seemed little prospect of finding anything suitable for our work. We were about to leave for other parts, when word was received of an infestation of the gipsy moth near Kaposvar, West Hungary, a considerable amount of stripping having been noted. Mr. Josef Ujhelyi, of the Hungarian National Museum, accompanied us on this trip.

Arriving at Kaposvar, we were met by a guide and conveyance. For some distance before we reached the forest we could see that a large part of it was defoliated and visions of trees, swarming with caterpillars were before us. We were doomed to disappointment, however, for the devastators were not *dispar* but the Cockchafer, *Melolontha vulgaris* L. A conservative estimate of the defoliated area would be over 50 acres. The entire place was teeming with beetles, and one could have easily picked up a quart of them in a few moments. Lying on the ground were many dead ones and some of them were collected for possible parasitism. These were held for some time and several Sarcophagid and one Tachinid puparia were secured. No adults issued and their identity remains unknown.

I have seen the work of *Melolontha vulgaris* in one locality or another every year that I have visited Europe. On one occasion, at Nyiregyhaza, East Hungary, a small area of perhaps twenty acres of oak growth was completely defoliated in 1923. The limits of the infestation, as shown by the defoliation, although unrestricted as regards food plants, were as clearly defined as if laid out by a surveyor. The adjacent growth was in full foliage.

The behavior of the insect is not always as I have pictured. Quite often it happens that the infestation is confined to a limited number of trees or even to a single tree. An instance of this sort was reported

by Dowden[10] at Bilky, East Czechoslovakia, in 1925. So abundant were the beetles in certain localities that often farmers passing by the infested places would stop, fill their hats with the beetles and carry them home to feed the ducks. In the forest, however, they were extremely scarce.

The same year an infestation of this species was noted at Debreczen, East Hungary, by Jones and Ujhelyi.[11] In this case the infestation was limited to the trees which adjoined a small cultivated area, the forest itself being quite free.

Although I have spoken only of the adult of *M. vulgaris*, it must be remembered that it is not in this stage, but in the larval stage, that most injury is sustained. Root crops of all descriptions are attacked and often suffer great losses.

The natural enemies of this insect are said to be few. Baer[12] reports but one Tachinid parasite, although two other closely allied species of *Melolontha* have given several others.

The life history of *Melolontha vulgaris* is as follows· Adults appear in May and June and deposit their eggs a few inches below the surface of the soil. The larvae hatch in two weeks or so and feed on the roots of various plants. They develop slowly, not reaching their full development until the third or fourth year. The pupal stage is passed deep in the ground and lasts for some time.

No satisfactory measures for control seem to be practised. Ploughing often turns up the larger grubs, which are destroyed, and the collection of adults for a few cents per quart is also resorted to.

Prof. Silvestri, of the Entomological Experiment Station, Portici, Italy, considers *Tortrix viridana* L. the very worst forest insect. It is quite possible that not all European entomologists would agree with him. There seem to be, however, few, if any, insects, periodic in their abundance, more commonly observed than this one. In going over my notes for the last four years, I find no less than 14 infestations recorded, few of which were in southern Europe.

In 1923, when returning from an unfruitful search for *dispar*, in Roumania, acre after acre of forests partially defoliated by *Tortrix viridana* could be seen from the train windows. The same year at Debrezcen, Hungary, there was a heavy infestation, the entire forest being infested and a certain portion of it was completely defoliated.

[10]Unpublished Gipsy Moth Laboratory Records.
[11]Unpublished Gipsy Moth Laboratory Records.
[12]loc. cit., p. 187.

It is interesting to note that the attack of this insect was followed by one from *dispar*. In two sections of oak growth, many trees stood practically defoliated for more than a month.

Debreczen being one of the points where the gipsy moth parasite work was established we were enabled to follow the progress of this infestation. There was no attempt to study its parasites, simply field observations being made. The infestation of 1924 was much lighter than that of the preceding year, the trees suffering only partial defoliation. In 1925 the species was scarcely noticeable unless one were searching for it. During 1926, specimens of either *T. viridana* or *P. dispar* were rarely to be found in this forest.

The life history and behavior of *Tortrix viridana* are similar to those of our own oak Tortrix (*Archips argyrospila* Wlk.). The species hibernates in the egg stage, the larvae hatching about April. Full development of the larvae is reached toward the end of June. The pupal stage lasts about two weeks, the adults emerging and laying their eggs on the bark of the trunk, and in lesser numbers on the limbs of the trees. The food plants are principally the various species of Quercus, besides many other species of deciduous trees.

In no forest that I have ever visited have I seen any control measures practised against this insect. Its natural enemies are numerous. A good account of these, with notations, as well as with much other information recently appeared in a publication by Prof. Silvestri.[13]

While investigating a gipsy moth colony near Cracow, Poland, we chanced upon a most serious outbreak of the Coniferous sawfly, *Diprion pallidus* Klug. It was of particular interest to us, as this insect was the overwintering host of *Sturmia gilva* Hartig, one of the gipsy moth parasites which we were seeking.

The oberforster of that section, having guided us to the locality where *dispar* was most abundant, suggested that we visit the nursery. Here were found many pine seedlings in very poor shape, and a few of them dead. Sometimes there would be from one to a dozen cocoons, either stuck to the plant or in the ground at its base.

The main forest, of *Pinus sylvestris*, many acres in extent, adjoins the nursery, and was heavily infested with this insect. From the nursery one could readily distinguish the trees that had been attacked by *pallidus*. There seemed to be every degree of feeding, a few trees were entirely defoliated (apparently dead), and the foliage of most of

[13]Contribuzioni alla conoscenza dei Tortricidi Delle Querce (1–11) Portici, Stab. Tip. Ernesto Della Torre, 1923.

the others appeared thin. Occasionally there was one that gave no indications of having been fed upon.

This was in 1924. The following year, the sawfly was again present and in such numbers that there was no difficulty in obtaining enough cocoons for our parasite work. I know of no better way to illustrate its abundance than by stating that five 100 lb. grain sacks were filled with the small cocoons of this sawfly within a few days notice. Furthermore, a month previously, in this same area, an equal quantity was collected by the oberforster for other purposes.

As is often the case, the next year our duties were elsewhere and I am unable to say whether the trees recovered or died and were felled. In either case the trees obviously suffered a severe setback during these three years.

In recent years a good deal of our gipsy moth parasite material has come from the Pandor forest, Baja, south Hungary. The forest land in this vicinity is of mixed growth, a large percentage of which is willow. In May, 1925, the willows over a large area were infested with one of the spittle insects (*Aphrophora salicis* de Geer). Scores of the trees were white with the froth-like exudation of these insects, which was dropping from the trees to such an extent that pools formed beneath them. So extraordinary in abundance was this insect that the *dispar* deserted the trees for other more desirable species. In 1926 the infestation was still present, but in much lighter proportions.

The extent of the injury caused by *salicis* was difficult to estimate. I do not believe that any of the trees were injured beyond recovery, but the brown and shriveled foliage indicated considerable damage.

One warm, humid morning as we were passing along the wood road that led to the insectary, we noted a peculiar pungent odor which my assistant immediately recognized as belonging to the blister beetle *Lytta vesicatoria* L. It did not take us long to locate them, as several partially defoliated ash trees gave evidence of their presence. This occurred in June 1925; one week later none of the beetles could be found.

In 1926 these beetles were again present in the same locality, appearing in about the same abundance, stripping a few trees and then disappearing. The trees which were attacked recovered rapidly and seem unaffected.

Species of the genus Hyponomeuta (Apple and Cherry Ermine Moth) are frequently seen in such numbers as to attract attention. Probably *Hyponomeuta malinellus* Zeller and *padellus* L. are the most important. Partial and complete destruction to the foliage of fruit trees has been

observed in Roumania, Bulgaria, and Hungary. In no instance have any of these observations been followed up, and the extent of the injury sustained remains unknown. A rather detailed account, including the life history and habits of the Ermine moth, has been published by Prof. P. J. Parrott.[14]

Deserving of much fuller details than my observations are able to supply, are such pests as the "forest-gardener," *Tomicus piniperda* L., the "Oak Procession Moth," *Cnethocampa processiona* L. and the "Lackey Moth," *Malacosoma neustria* L. In the pine forests of Poland I have seen the ground strewn with terminal shoots, the work of *T. piniperda* and often in the oak forests of Central Europe innumerable masses of old molted skins were indicative of a former abundance of *C. processiona.* M. *neustria* is invariably present in more or less abundance, either on fruit or on forest trees.

The Coleopteron *Anisoplia austriaca* Hbst. is a common insect, and in 1926 was to be found in many grain fields throughout Central Europe. It is not thought to be very injurious.

All of the insects mentioned have received more or less attention from various authors. Another species less frequently encountered, which injures man and animals, is the Columbacz midge (*Simulium columbaczense* Schoenbauer). It has an evil reputation, and the economic losses caused by it are considerable. It is even said that it has caused the death of children.

In southern Hungary, and especially along the lower Danube Valley, it is very common. Its life history, which is similar to that of other related species, has been published by Dr. Horvath.[15]

A unique method was used by the wagon men to protect their oxen from this pest. Slung from the tip end of the pole that separates the animals was an iron pot from which arose a black smudge. In spite of the fact that the animals' noses and eyes were continually filled with smoke, it was apparently less annoying to them than were the flies. Evidently they were accustomed to it. We were told that the fuel used was corn-cobs and husks, soaked in tar.

These observations, obviously limited to well known pests, are presented for the purpose of emphasizing the danger that attends the introduction of some foreign insect. Only brief experience is needed to appreciate the difficulty of securing accurate data, especially on species

[14]Jour. Econ. Ent. III, p. 157, 1910.

[15]A. Kolumbacsi legy, Dr. Horvath Geza, in Rovartani Lapok, Vol. 1, No. 10, Budapest, 1884.

of supposed lesser importance. Far too little is known of the actual history of many of these likely to be introduced to warrant us in ignoring or risking their establishment.

PRESIDENT ARTHUR GIBSON: We will now listen to a paper by A. W. Morrill.

OBSERVATIONS ON A NEW AND IMPORTANT COTTON PEST

By A. W. MORRILL, *Los Angeles, California*

(Withdrawn for publication in a later issue.)

PRESIDENT ARTHUR GIBSON: The next paper is by S. M. Dohanian.

SOME OF THE IMPORTANT FOREST INSECTS OF WESTERN EUROPE

By S. M. DOHANIAN, *U. S. Bureau of Entomology, Melrose Highlands, Mass.*

ABSTRACT

Several insects attacking the oaks and pines in the forests of western Europe are mentioned, together with their life histories and methods of control.

INTRODUCTION

During the greater part of the past three years the writer has been engaged in entomological activities in western Europe. In 1924 and again in 1925 he was detailed by Mr. A. F. Burgess, of the U. S. Bureau of Entomology, for work there in connection with the study and importation into the United States of the natural enemies of the gipsy moth and the brown-tail moth. Late in 1925 and early this year he investigated, for an American commercial concern, methods of artificial control for some of the most serious pests of grape vines, greenhouse insects, and certain subterranean insects and rodents. Incidental to, and in connection with, these various studies he has accumulated notes on some of the important insect problems, not only through personal studies and observations, but also by means of conferences and consultations with entomologists in the several western European countries he has visited. These countries are Spain, Portugal, France, Switzerland, Italy, Germany, England, Austria, and Holland.

We learn from history, as well as from entomological tradition, that even during the period of the American Revolution, when travel was slow, injurious insects were transported long distances and introduced into new areas thousands of miles from their native homes. Since

those days scores of insects have been transported, accidentally or otherwise, from their native habitat, and having become established in their new environment caused enormous economic losses. This danger becomes increasingly imminent with the rapid development of the swifter methods of transportation and desire for travel characteristic of our era. This paper is presented in the hope that the biological information it contains may be found useful in combating any of the species discussed in the event of its trespass into American territory. Usually considerable time is lost in the preliminary studies of its life history and habits, during which a new invader gains much headway, not only in increasing its numbers but also in the area infested.

The Forests of Western Europe

No official figures were given me of the areas under forest canopy for any of the countries except in the Iberian Peninsula. In Spain and Portugal approximately 49 per cent of the land is devoted exclusively to forest growth. In both of these countries the dominant species are oaks and pines, which comprise some 80 per cent of the total growth. Among the other species of economic importance may be mentioned chestnut, ash, elm, poplar, maples, willow, etc. In these two countries and in Italy the predominating oak species are, in the order of their importance, *Quercus ilex*, cultivated for its prolific acorns for hog food, *Q. suber* (the cork oak), *Q. sessiliflora*, *Q. robor*, *Q. lusitanica*, *Q. pedunculata* and *Q. toza*. The six important pines are *Pinus sylvestris*, *P. pinea*, *P. halepensis*, *P. austriaca*, *P. pinaster* and *P. strobus*.

It is not intended even to mention here all of the important insect pests of western Europe, but to discuss in detail a very few of the most serious and persistent enemies of the forests with which the economic entomologists of Europe must contend.

The Oak Pests

The gipsy moth (*Porthetria dispar* L.), a pest of the first order over all Europe (except probably the Scandinavian countries), is sometimes controlled by its numerous natural enemies, but periodically makes its appearance as a serious devastator. The brown-tail moth (*Nygmia phaeorrhoea* Don.) attacks both forest and fruit trees. Its behavior in Europe closely resembles that in America, where it is now assuming the rôle of a native insect. It is interesting to note that in Spain, where it is more common in the forests than on fruit trees, it will not feed on the evergreen oaks, but confines its damage to the deciduous oaks and to elms. In Italy it is a pest of both forest and fruit trees, being found

at times in abundance even on the "horse chestnut," *Aesculus hippocastanum*. In mid-December, 1925, while traveling from the Rhine Valley in Germany to Switzerland, the writer saw webs of the brown-tail moth on fruit trees along the line of the railroad, perhaps more abundantly than he has seen them at any other time either in America or in Europe. For a distance of between 25 and 30 miles there did not seem to be a single tree unmolested by this pest. A majority of them harbored hundreds of webs. The admirable "clean-up job" done here is worthy of emulation, for on March 21, 1926, when the identical journey was being repeated, not *one* web could be seen on the trees. Where thousands upon thousands of webs existed three months before, not even one could be seen now. Every one of those webs had been cut and undoubtedly burnt.

Both the brown-tail moth and the gipsy moth, but particularly the latter, appear to favor chestnuts more in Europe than they do in America. In the summer of 1924 the gipsy moth completely defoliated a chestnut grove of several hundred acres in Tessin, in southeastern Switzerland. Dr. F. Stellwaag, of Neustadt, Germany, lists 34 parasites as enemies of the brown-tail moth, and the same number of parasites which aid in keeping the gipsy moth in check in Europe.[1]

Another general pest very common in all of western Europe is *Bombyx neustria* L. Evidently this insect is found generally throughout Europe, for Mr. R. T. Webber, of the Bureau of Entomology, while scouting for parasites of the gipsy moth and the brown-tail moth during the year 1924, reports it rather abundant in eastern Europe (Roumania) and also in central Europe (Czechoslovakia). This species also is not fastidious in its choice of food plants, but attacks forest and fruit trees equally well. Among the former may be mentioned oaks (of which the deciduous varieties are preferred), poplars, beech, hornbeam, while the apple, pear, apricot, cherry and mulberry are the fruit trees on which it is most abundant. The production of fruits is seriously handicapped by the feeding of the larvae on the foliage. Its biology is similar to that of the American tent caterpillar of this country, to which species it is closely related. The female moth deposits her complement of eggs, 200 to 300, cementing them on small twigs in the form of a ring not unlike those of our American species. These overwintering eggs hatch from about the middle of April to early in May. The larvae become full grown after feeding about two months, the single annual generation being completed by the appearance of the adults in July.

[1]Stellwaag, Dr. F. "Die Schmarotzerwespen als Parasiten." Monog. zur angewandten Entom., No. 6, pp. 88–91, Berlin, 1921.

There are recorded five larval parasites, and five which attack its eggs. The artificial methods of control recommended by Europea entomologists are to collect and burn the egg masses, and to spray the foliage of infested trees with arsenicals. Some success has been achieved by the latter method in Spain, where the spraying was done in combination with that for *Tortrix viridana* and *Porthetria dispar*.

Among the enemies of deciduous forest trees, and one that confines its activities solely to forest growth, perhaps there is none that causes more damage than a Tortricid which is found almost everywhere in Europe. The writer is familiar with its ravages in western Europe, while Mr. S. S. Crossman, of the Bureau of Entomology, has reported it as abundant in some of the central European and the Balkan countries during his research travels in these countries in 1923 and 1924, in connection with the gipsy moth and brown-tail moth projects. It would be exceedingly difficult to estimate the annual loss caused by *Tortrix viridana* L. It is a most voracious feeder on the flowers and foliage of the oaks. It has but a single generation a year. The time of hatching of the overwintering eggs and the length of the larval period vary greatly. Normally it is said to hatch in Portugal late in February and early in March; in Spain, late in March and early in April; in Italy, about the middle of April, and in France, about the first of May. The length of the larval period—the stage in which it does its mischief— also varies considerably in different parts of Europe. In Spain and Italy larvae may be found in the field for only about 4 weeks, while in Portugal and England they feed continuously for about 10 weeks. The pupal stage is about 10 days, and two or three days after the adults have emerged mating takes place and the females begin depositing their eggs. The eggs are laid singly or in groups of twos or threes, but not in masses, as is the case with the gipsy moth and the tent caterpillars. Each egg has an outer envelope, bearing scales from the abdomen of the female moth. The female selects locations very near the buds to deposit her eggs; and almost invariably on the current-season's growth or on the growth of the previous year, for, directly upon hatching, the young larvae go there to feed on the bursting buds and flowers. In 1924 an attempt was made in Portugal to control this insect by taking advantage of this habit of depositing its eggs only on the growth of the current season and on that of the season previous. The federal agricultural school authorities in the Province of Beja, in southern Portugal, believed that if all such growths on *Quercus ilex*, the favored food plant of this pest, was cut off early in the winter and the trash burnt, all the eggs in the

area would be destroyed and the pest would be exterminated. Accordingly a large plot of 46 hectares (approximately 100 acres) was selected in the heart of the 300 hectare forest owned by the school, and all of the growth of 1923 and 1924 was carefully cut and burnt. When the writer saw this experimental plot in the spring of 1925 it was a sorry looking sight, without a green leaf in evidence, in sharp contrast to the surrounding evergreen oaks. That this plot will not be defoliated by *Tortrix viridana* for 3 or 4 years seems assured, but the fact that both the male and female moths are capable fliers appears to have been overlooked when this experiment was planned. It is a matter of time only, probably 4 or 5 years, before the pest becomes just as abundant here as it ever was before this unique treatment.

On valuable woodlands this pest is controlled artificially by spraying with arsenicals. And this can be done quite economically, for *Q. ilex* seldom grows to a height of more than 30 or 35 feet and the trees are cultivated far apart. Furthermore, spraying for *T. viridana* can be timed also to take care of the early stages of the gipsy moth and of *B. neustria.* Usually one of these pests is found in combination with one or both of the other two.

Over Europe generally *Tortrix viridana* has a formidable array of natural enemies. There are more than 40 parasites of the larvae and pupae,[2] exclusive of predators and the egg parasites. It seems reasonably certain that there are some parasites of the eggs, although so far as I know to date none have been found. Probably the difficulty of locating the small, inconspicuous, and isolated eggs is chiefly responsible for the lack of knowledge concerning its parasites. Despite the large number of natural control agencies *Tortrix viridana* has been abundant in the central and southern countries of Europe over a long period of time.

The Pine Pests

Several important Scolytidae and Aphiidae attack the pines of western Europe, but the principal enemies are *Thaumetopoea (Cnethocampa) pityocampa* Schiff., and the Tenthredinid *Lophyrus (Diprion) pini* L.

The first of these is commonly known as the "Procession Moth" and can be found in practically all pine stands of southern Europe and France. This insect has a single generation a year. The female deposits its eggs about the middle of July, these hatching about four weeks later. The gregarious young larvae then form a common web to which they

[2]Seabra, A. F. de, et Dos Santos Hall, F. A. "Contributions pour l'Histoire Naturelle des 'Tortrix' der Chêne-vert a l'Alentejo." Mem. et Études du Mus. Zool. de l'Univ. de Coimbra, Portugal, 1925. Ser. II. No. 1, pp. 11–45.

return after feeding. Feeding continues until late autumn, when, just before going into hibernation, the web is greatly strengthened. This web is composed of a series of connected tunnels, with a rather large opening for communication with the exterior. The average size of these webs is larger than that of the American tent caterpillar so common in New England. The larvae recommence feeding with the very first days of spring, becoming increasingly ravenous as the time for pupation approaches. About the middle of May the full grown larvae abandon their companions and common home, and migrate to the soil beneath, where they pupate from 3 to 4 inches below the surface. The adults emerge late in June or early in July. The procession moth receives its name from the habit of the larvae of searching for food in regular columns or files. One larva will lead "the procession," the head of the second larva touching the posterior segment of the leader, and the head of the third touching the last segment of the second, and so on down to the last larva. An inquisitive French entomologist, desirous of learning just how long they would "follow the leader," regulated the march of the leader of a certain procession so that it finally had its head touching the posterior segment of the last one in the march, the entire colony thus forming a complete ring. He discovered that this particular procession continued for 72 hours before one of the number finally decided to break away in an independent search for food, and the others followed meekly.

Although none of the many species of pines are free of the attacks of this pest, there appears to be a decided preference for *P. sylvestris*, *P. pinaster* and *P. halepensis*. The defoliations caused by the larvae of the procession moth weaken the trees, rendering them subject to the attacks of other insects, but specially of certain Scolytidae. Because it has but a single generation a year this insect is said to be incapable of killing pines. But pine stands are unable to survive the combined attacks of the procession moth and the borers. For the control of the moth the following treatments are recommended: (1) cutting and burning the webs; (2) collecting and killing the larvae; (3) spraying with lead arsenate, and (4) pumping kerosene into the webs by a small hand injector.

The most obnoxious hymenoptera in Europe are members of the tenthredinid genus Diprion (Lophyrus), of which *pini* L. and *pallidus* Klug are the worst offenders. The former, *D. pini*, is said to be abundant generally throughout Europe wherever pines are to be found. Although it is reported to favor isolated pines, or those in very open-

grown stands, it will attack as readily pines in thick groves. It is exclusively an enemy of pines. In Italy its cycle of destructive invasions is said to be about twelve years. The female, upon emergence early in April, inserts her eggs singly in lacerations which she makes for the purpose in the needles of the preceding season. In two or three weeks the eggs hatch and the young larvae at once commence to feed on the more tender needles. If, however, these are not sufficient they will also attack and completely devour the two-year-old needles. After about two months' feeding a strong cocoon is spun by the mature larva in which to pupate. These cocoons are attached to the rough bark of the trunk or branches.[1] In two or three weeks after pupation the second generation adults emerge. Prof. Giacomo Cecconi, of Fano, Italy, states that the full grown larvae of the second generation migrate into the soil to form their cocoons in which the larvae hibernate; pupation occurring in the cocoons soon after the beginning of March.

The method of control recommended is the collection and destruction, by hand, of the larvae and cocoons; spraying the pines with a 1 per cent solution of lead arsenate is said to be effective in killing the very young larvae. *D. pini* is said to be subject to attack by a great many parasites. Birds also aid in keeping its numbers down.

The writer secured fragmentary notes on some other forest insects of western Europe and fuller notes on several others injurious to agriculture in general. These have been omitted above, but it is hoped that they will be eventually recorded in American literature. As has been previously stated, these notes and observations were made while engaged on studies of the parasites and predators of the gipsy moth and the brown-tail moth, without any loss of time and at no additional cost than that incurred in the proper execution of that project. This illustrates one of the attendant benefits derived from necessary foreign work in entomology.

PRESIDENT ARTHUR GIBSON: Mr. T. E. Snyder will read the next paper.

TERMITES MODIFY BUILDING CODES

By THOMAS E. SNYDER, *Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

Forty-two species of termites are widely distributed throughout the United States and, due to the fact that the untreated woodwork of buildings is often directly in contact with the ground, termite damage to buildings throughout Eastern United States, the Gulf States, Southwest, Central West and Pacific Coast is serious. The

only effective permanent preventive and remedy is the proper construction of buildings. Insulation of all untreated woodwork from contact with the ground and termite shields will protect against subterranean termites, whereas against the nonsubterranean termites the interior woodwork and furniture must be impregnated with chemical preservatives. In Honolulu, Hawaii, a million dollars is the annual damage to buildings done by termites. This city has recently adopted a building code containing 14 points relating to termite control; 80% of the frame buildings in New Orleans have been damaged by termites and 50% of the business buildings at Pasadena, Calif., some dangerously. Slightly modified building codes for the entire west coast, from Seattle to San Diego, are being considered. The aim of the Bureau of Entomology is standardized, uniform, modified building codes for all the regions where termite damage is serious.

Owing to lack of information on the destructiveness of our forty-two species of termites or white ants, and their wide distribution throughout the United States, buildings are often erected with untreated woodwork directly in contact with the ground, leaving the way open for the entrance of subterranean termites.

In consequence of such improper construction, termites burrow into the wood and may greatly damage the woodwork of the building before their presence is detected. It is a great hardship for a man on a moderate salary to make a large initial outlay on a new house and, after one or two years, be forced to expend several hundred dollars additional to reconstruct the building to eliminate termites. The cost of repairing termite damage to buildings and preventing further attack averages from $500 to $2000, but in some cases is as high as $10,000 to $25,000.

Termites in the United States

Despite popular opinion, practically all the termite damage in the United States is done by native species and such serious damage occurs throughout eastern United States, the Gulf States, Southwest, the Central West and the Pacific Coast. Damage by termites in the "corn belt" is almost as serious as in some of the Southern States. Such damage by termites occurs not only in cities but also in rural regions.

Termites of two distinct types occur in this country. Those subterranean in habit burrow through the soil and only attack wood indirectly from the earth, with which they must maintain contact, to obtain the moisture so necessary to their life. (Pl. 8) Subterranean termites are widely distributed throughout the United States, over most of which they damage buildings.

Nonsubterranean termites never burrow in the earth, but attack wood directly; they do not require much moisture and will survive in wood containing less than the 10% moisture content normal to air dried wood; small pellets of digested wood betray their presence. These

"powder-post" termites are not widely distributed and damage to buildings only occurs in that half-moon of country, lying between a slack line from Norfolk, Va., to San Francisco, Calif.

Insulation Against Subterranean Termites

The only effective permanent preventive and remedy is the proper construction of the building with the knowledge of the habits of termites and the specific that will eliminate them. This specific against subterranean termites is "insulation" of all untreated woodwork from contact with the ground; it can be accomplished by the use of stone, concrete or brick foundations and lower flooring or the use of foundation timbers impregnated with coal-tar cre osote and metal termite shields. The greatest portion of all termites which damage buildings in the United States are of subterranean habit; if they can be kept from reaching woodwork from the ground they cannot survive in the building. Also, if present in a building, after all untreated wood, such as joints, wooden floors, sills, etc., has been removed from contact with the ground, they will die out, i. e., dry up; even if the termites have penetrated to the height of several stories in the building. They have been cut off from their moisture supply in the ground which is necessary for their life.

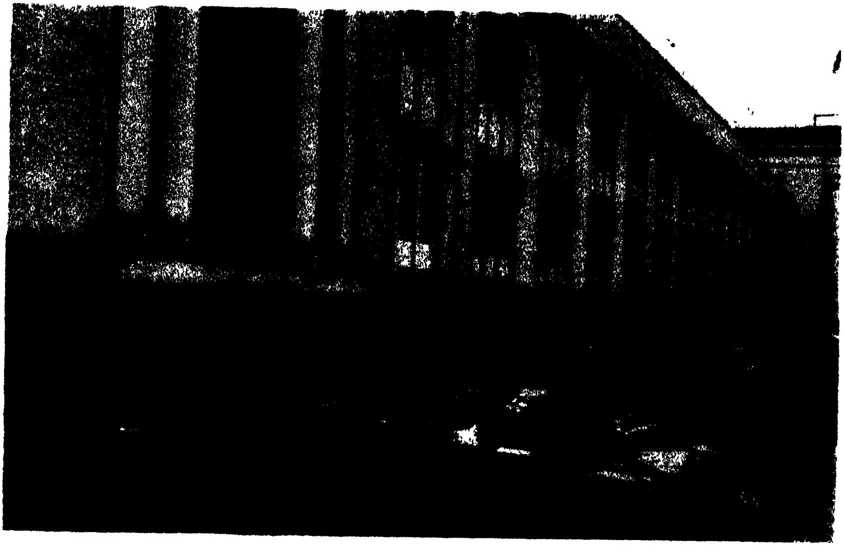
Impregnation of Woodwork against Nonsubterranean Termites

Where termites that attack wood directly and not from the ground occur, as well as subterranean termites, it is suggested that only woodwork impregnated with preservatives be used for exterior and interior construction, unless it is impracticable to obtain such treated wood. While impregnation with coal-tar creosote is the most effective treatment for foundation timbers to be set in contact with the ground, for interior woodwork and furniture, and the like, not in contact with the ground, impregnation with zinc chloride or other standard preservatives, is recommended; wood so treated can be finished and painted.

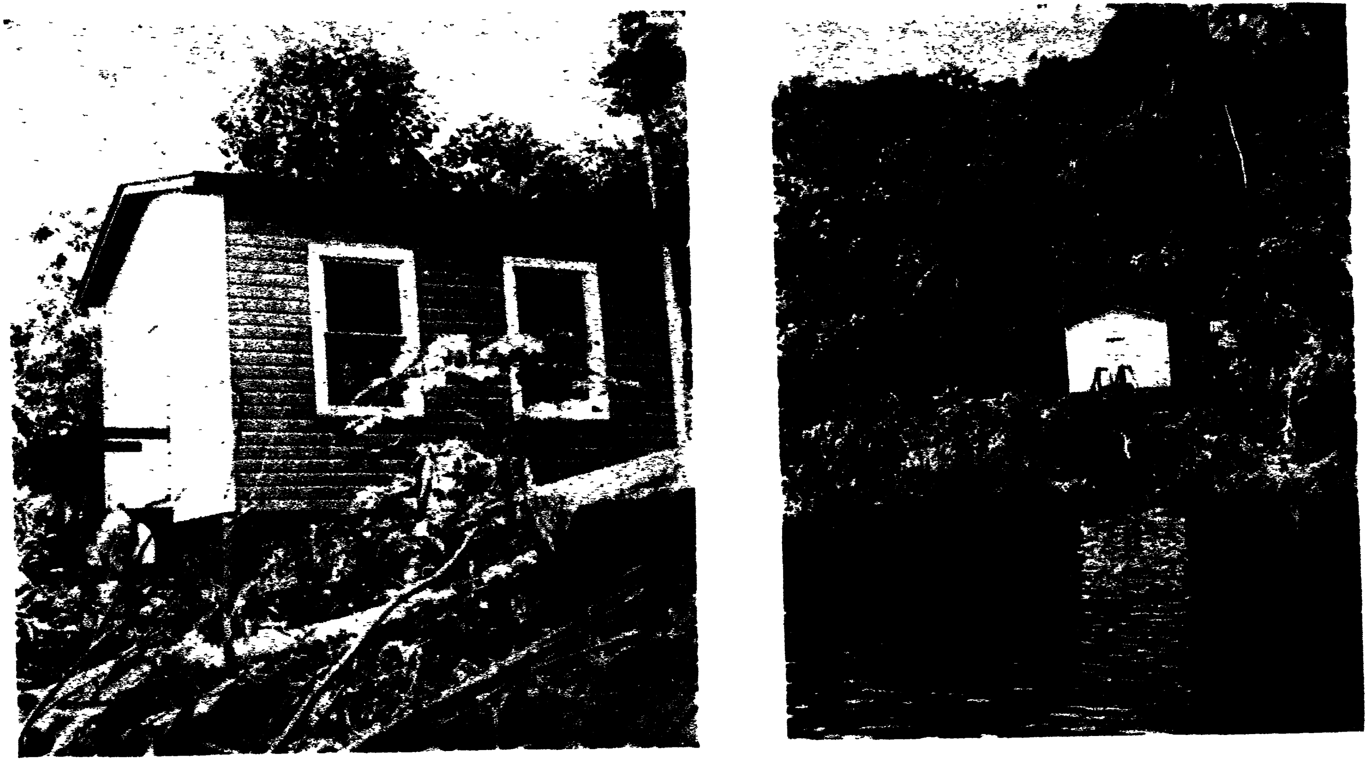
Building Code Modification

In 1923 the first attempt was made to have building codes modified to prevent termite damage and this was made in Burlington, Iowa, where efforts were made to have no untreated wood placed in contact with the ground but that all such timber should be treated with coal-tar creosote.

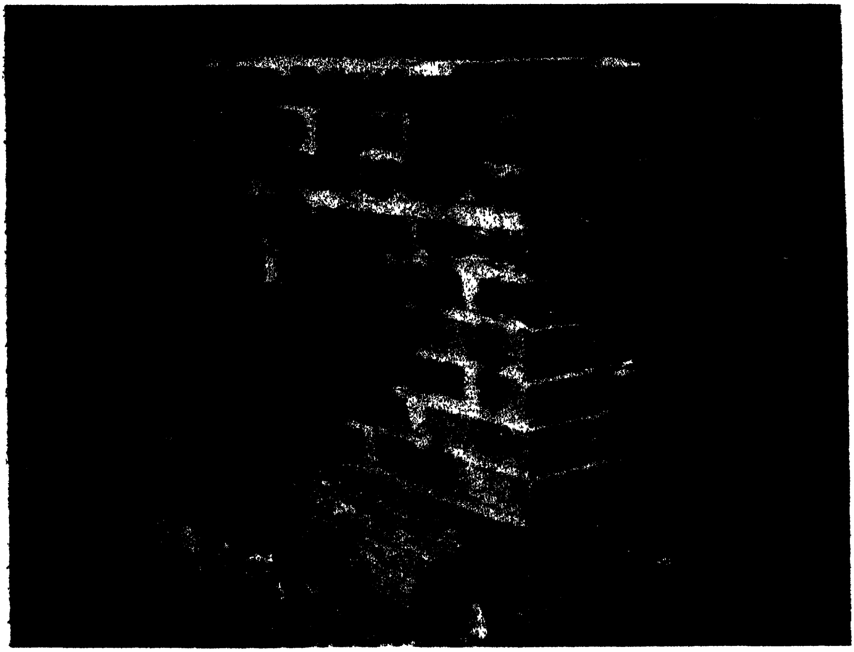
Recently the Bureau of Entomology of the Department of Agriculture has been widely advocating the slight modification of the building regulations of various cities so as to include simple rules to prevent attack by these insects. This educational propaganda addressed to city



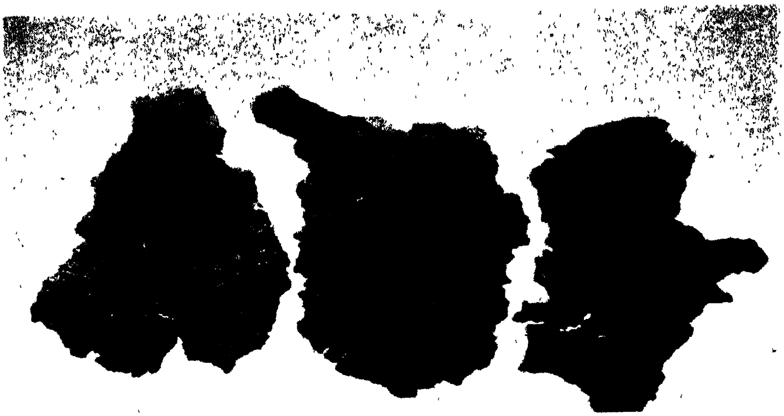
Temporary government building at Washington, D. C., the untreated wooden foundations of which were weakened by subterranean termites (Reticulitermes). $140,000 were spent in repairing temporary wooden government buildings at Washington, D. C., in 1926, that could have been saved by using concrete foundations or timber impregnated with coal tar creosote.



All wood, model termite-proof building erected on Barro Colorado Island, C. Z., Panama, to demonstrate that timber grown in the United States, properly impregnated with preservatives will prevent termite attack.



Tests at Falls Church, Va., of mortars and concretes for brick foundations on or below the surface of the ground; suitable mortars and concretes will prevent both mechanical and chemical action by subterranean termites.



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See page 319 for explanation of figures.

engineers has been conducted with the assistance of the National Lumber Manufacturers' Association, the United States Department of Commerce, Lumber Division of the Bureau of Foreign and Domestic Commerce, the American Wood Preservers' Association and the Associated Press. The National Wood Utilization Commission appointed by President Coolidge, with Secretary Hoover as chairman, has an ant-proofing campaign on its program, which will receive early action.

Termite-proofing buildings campaigns have been advised in certain cities similar to that conducted by the Public Health Service in rat-proofing. Indeed rat-proofing, fire stops and the prevention of decay and insect damage can all be effected by similar methods.

In rural regions where there are no building codes or chambers of commerce, the educational work can be conducted by prominent citizens with the help of county agricultural agents.

In Honolulu, Hawaii, a million dollars is the annual damage to buildings done by termites; this city has recently adopted a building code containing 14 points relating to termite control; 80% of the frame buildings in New Orleans have been damaged by termites and 50% of the business buildings at Pasadena, Calif., some dangerously. Slightly modified building codes for the entire west coast, from Seattle to San Diego, are being considered. Similar serious damage occurs in southern Florida and in the southwestern states. The aim of the Bureau of Entomology is standardized modified building codes for all the regions where termite damage is serious. The Pacific Coast Building Officials' Conference of Long Beach, Calif., is already in consultation with the Bureau of Entomology.

Hits Small Householder

While special effort has been made to protect the small householder from speculative and careless builders many of the more permanent modern buildings are improperly constructed. This applies to some of the government buildings in Washington. With the cooperation of the Superintendent of Public Buildings and Grounds much progress has

1.—Builders are finding that while tar and tar paper are used in water-proofing wood used in floring, these substances will *not* prevent attack by our native subterranean termites or "white ants". These insects penetrate such moisture-proofing materials and carry to the wood the moisture necessary for their life. Insulation of wood from the ground by the use of concrete or by impregnating wood with coal-tar creosote is necessary to protect it from these subterranean termites.

2.—Inferior grade of mortar penetrated by subterranean termites in brick foundations of buildings in Maryland.

3.—Inferior grade of concrete penetrated by subterranean termites in locks, Panama Canal.

been made in repairing such buildings and some such work has been done with temporary buildings where practicable.

The use of untreated wood in the foundation of buildings is a great waste of wood and the replacement cost is often very much greater. A model demonstration, termite-proof building has been erected in Canal Zone, Panama (Pl. 9) by the American Wood Preservers' Association and associated companies in consultation with the Bureau of Entomology to serve as an object lesson; other similar buildings are to be erected in the United Statees.

The Modified Code

No foundation timbers, floors, sills, clapboards, etc., of untreated wood should be laid on or in the earth, and untreated beams must not be laid in concrete without at least one inch of concrete underneath and separating it from the earth. A special grade of hard mortar (Pl. 10 and 11, figs. 2, 3) should be used in making cement for foundations or in cellar walls where they are in contact with the earth, since termites are able to penetrate certain kinds of mortar after some years' service. For greater safety all brick work extending below the surface of the ground should be faced and capped with concrete at least one inch thick. Metal termite guards should be provided between the earth and treated foundation timbers, stone, brick or concrete foundations. Termites construct over impenetrable substances earth-like shelter tubes of small diameter through which they travel to reach untreated wood. In consequence they can be kept out of buildings by means of metal barriers. By simply inserting a sheet of galvanized iron, zinc or copper or "termite shield" into the masonry and turning the projecting edges downward at an angle, communication of termites with the earth, where they obtain moisture, can be cut off. In less pretentious frame buildings, metal caps are placed over the tops of construction stone piling or pillars, or wooden supports. Tar is no protection for wood. (Pl. 11, fig. 1).

This is a similar method to that used in rat-proofing corn cribs. It is effective and practicable where untreated timber is placed over masonry foundations. These shields need not be unsightly but can be made decorative or ornamental.

These slight modifications of the building regulations of cities by city engineers would save much property as well as the time and worry to householders. It is a form of house insurance. A prospective home builder should insist on obtaining this safeguard! It will pay in the end!

There are three principal points—insulation of untreated woodwork

from the earth, metal termite shields to shut off the shelter tubes and treatment of interior woodwork and furniture with preservatives; the latter recommendation is essential only in the Gulf States, Southwest and southern California.

Mr. E. V. Walter: I would like to ask if there are any kinds of wood that are not bothered.

Mr. T. E. Snyder: There are some woods which are very resistant to termites. Redwood is one, provided it is not in contact with the ground. Redwood has been used very successfully in the Philippines and Central America. We know of no species of wood anywhere in the world that is immune to attack.

Mr. E. V. Walter: How is cedar?

Mr. T. E. Snyder: The heartwood of cedar is very resistant.

President Arthur Gibson: The next paper is by A. G. Ruggles.

THE GREEN BUG IN MINNESOTA[1]

By A. G. Ruggles and F. M. Wadley

Abstract

The green bug, *Toxoptera graminum* Rond., destroyed about 15 million bushels of oats in Minnesota in 1926. The cool, dry June was very favorable for the development of aphids.

Certain facts so far discovered in the biology of the insect make it appear that the insect did not overwinter in Minnesota but was blown in by the wind. The weather records show that strong winds at favorable dates might be responsible for such an infestation.

In 1926, Minnesota, for the first time in its history, was the center of a green bug infestation. It seems to have been the only outbreak of importance in the entire country during the year. The first report (concerning the green bug injury) came to the office about June the 10th. Previous to this time, the farmers had attributed the injury to the dry weather or to the frost. When the grain did not improve after ample rains early in June, a few progressive farmers examined their fields and found plant lice present. They immediately got in touch with experts at the Experiment Station. Dr. C. E. Mickel visited the scene of the outbreak and pronounded it the work of the green bug. Dr. Mickel kept closely in touch with the injury during the entire season and both he and the junior writer traveled over the state, noting the spread of the insect. On June 10th, the outbreak was in an advanced stage in a

[1]Published with the approval of the director as paper No. 662 of the Journal series of the Minnesota Agricultural Experiment Station.

definite area covering parts of Kandiyohi, Stearns and Meeker counties. There seemed to be no focal point for the infestation. The numbers of aphids were equally distributed over the whole area. By the third week in June, adjoining counties were showing injury and the aphids were beginning to be found widely over the state.

Injury in the first area increased very fast during the second week of June. In general, the infestation followed this same course in its development in each locality. The food plants began to die, winged forms developed and migrated, those remaining wingless died for lack of food or fell victim to enemies and the numbers fell off very suddenly. The map shows approximate dates of maximum numbers in each locality. It will be noted that this gives roughly a concentric arrangement. The inner circle represents the area of primary infestation, while infestations outside this area are thought to be secondary and to have originated from the first by means of migrating forms. Early oats were attacked in the primary area, while late oats were attacked over the rest of the state. Had the aphids developed simultaneously in all parts of the state, it does not seem possible that early and late oats would have been attacked in this manner. At the northeast experiment station at Duluth, late oats sowed June 4th were attacked before June 20th. The migrants evidently were coming in here about June 15th. Flying swarms characteristic of green bug outbreaks, were observed by different members of the staff. Depending upon the prevailing winds, they flew southeast, west and north.

In August green bugs had become very scarce all over the state, but a few could be found in volunteer grain around elevators and mills nearly everywhere. In September they seemed to increase slightly and some migrants developed. In October decreases occurred and they disappeared altogether from a number of localities.

Injury

Oats were severely injured, wheat much less, and barley and rye were not perceptibly injured even in the region of the most severe damage.

In the original infested area in west central Minnesota, damage was very heavy. Some field were plowed up and planted to catch crops or abandoned; others yielded poorly with spots entirely destroyed. Many fields in counties adjacent to this area were more or less severely injured. In southern and eastern Minnesota in general, only very late fields were strikingly injured, but all oat fields contained some green bugs, and many must have been slightly reduced in yield. In northern Minnesota late fields were considerably injured. In the Red River valley, an im-

portant grain area, green bugs became abundant and somewhat injurious in places. Though the drought of early spring and summer was quite general, many fine oat fields were seen in sections not severely affected by green bugs.

In the state as a whole, the oat crop estimate of December 1 was about 130 million bushels. If the acre yield had come up to the average of the five preceding years, the crop would have been about 165 million bushels. Barley is a crop governed by the same conditions as oats and raised all over the state. The barley acre yield declined 7 per cent from the 5-year average which can properly be accounted for by drought. Eleven million bushels of the decline in the oat crop can therefore be attributed to drought. But the actual decline was 35 million bushels. Unpublished figures from the U. S. Bureau of Crop Estimates, secured from the Division of Farm Management at Minnesota, covering conditions from 1919 to 1923, indicate a high degree of correlation in the oat and barley yields in the state. In both dry and moderate years, estimated drought damage to oats and barley was always nearly the same. Hence drought cannot account for any drop in the oat yields over 11 million bushels. Some factor not affecting barley is responsible for about 24 million bushels reduction in the oat crop, and excepting the oat rust the green bug is the only important one we know. We believe 15 million bushels of oats a conservative estimate of green bug loss in Minnesota in 1926.

Biological Notes

The green bug matures in about 8 days at 70°F. and 12 days at 60°. It will not develop at all below about 45°. Minnesota summer temperatures seldom rise high enough to interfere with its activities, even temporarily. It may reproduce from two weeks to nearly a month, at an average rate of 3 or 4 young per day with a maximum of 8. Apterous parents on oats have produced 51 to 83 young, averaging 68; winged females, few, up to 50. Aphids on wheat produce fewer young than on oats, the preferred food plant. Fewer young were produced after the sexes began to appear.

The sexes were not produced outdoors this fall, either in the field or in outdoor cages. In the outdoor cage, one oviparous female was seen early in November, just before permanent freezing weather set in, but too late to produce eggs. In the greenhouse the males, females and eggs were produced in some numbers. It appeared that Minnesota temperatures are too low for much development after the factor producing the sexes begins to operate in October. This accords in general with Vickery's and Webster's results in 1907 (Minn. Bul. 108). The other

two species of common grain aphids, *Macrosiphum* and *Rhopalosiphum*, produced the sexes outdoors in October. All but a few green bugs survived a temperature of 24°F.; nearly all died at 8°; the remainder perished when a cold spell carried the temperatures down to about 0°F.

Besides oats and wheat, the green bug will multiply to some extent on bluegrass and orchard grass. It increases on wild oats. On other grains, and annual and perennial grasses occurring commonly in Minnesota, we have not been able to colonize it permanently, though it may feed and stay a few days. On all plants on which any amount of feeding is done, red spots appear due to killing of leaf tissue. This factor and the green bug's habit of concentrating their attack until the plant is killed, and then migrating in a body, give the species its highly injurious character. The numbers of aphids will reach from 2000 to 4000 per square foot before oats go down from their attack.

The ladybird beetles were most important as aphid enemies during the outbreak. *Coccinella 9-notata* Hbst., *C. transversogutta* Fald., *Hippodamia convergens* Guer., *H. 13-punctata* Linn. and *H. parenthesis* Say were the only ones to become numerous. They reached great numbers owing to the abundance of food, a brood maturing late in July. From 3 to 18 per square yard occurred in infested fields. Adults will consume 25 to 50 aphids a day. Syrphids were next in importance and in earliness of appearance. Hymenopterous parasites were present, but did not become numerous and were late in appearance; Chrysopids scarcely appeared before the outbreak was over. A Cecidomyid species destroyed aphids in the greenhouse.

The Origin

The origin of this unprecedented northern outbreak is a highly interesting question. Though most early and severe in Minnesota, it extends, according to information given by entomologists and reports from the Crop Pest Survey, from North Dakota to Ohio and from Iowa to Manitoba. Mr. Nelson, an elevator manager in the original infested area, reported and described unmistakably an outbreak near Jamestown, North Dakota, late in June. In Wisconsin, infestation reported in the western part can be logically related to the Minnesota spread. This is also true in South Dakota. A center in northeast Wisconsin and adjacent upper Michigan, and another in southeast Wisconsin, cannot be so related. In Iowa two small centers were reported, one in central and one in western Iowa. There were also reports from Ohio and Indiana. In south central Kansas, the junior writer observed green bugs appearing late in April and increasing to a small extent in May.

Professor Dean reported a very light infestation in Kansas. Professor Sanborn spoke of the green bug wintering successfully, and increasing in early spring in north central Oklahoma. No reports have been received from Nebraska.

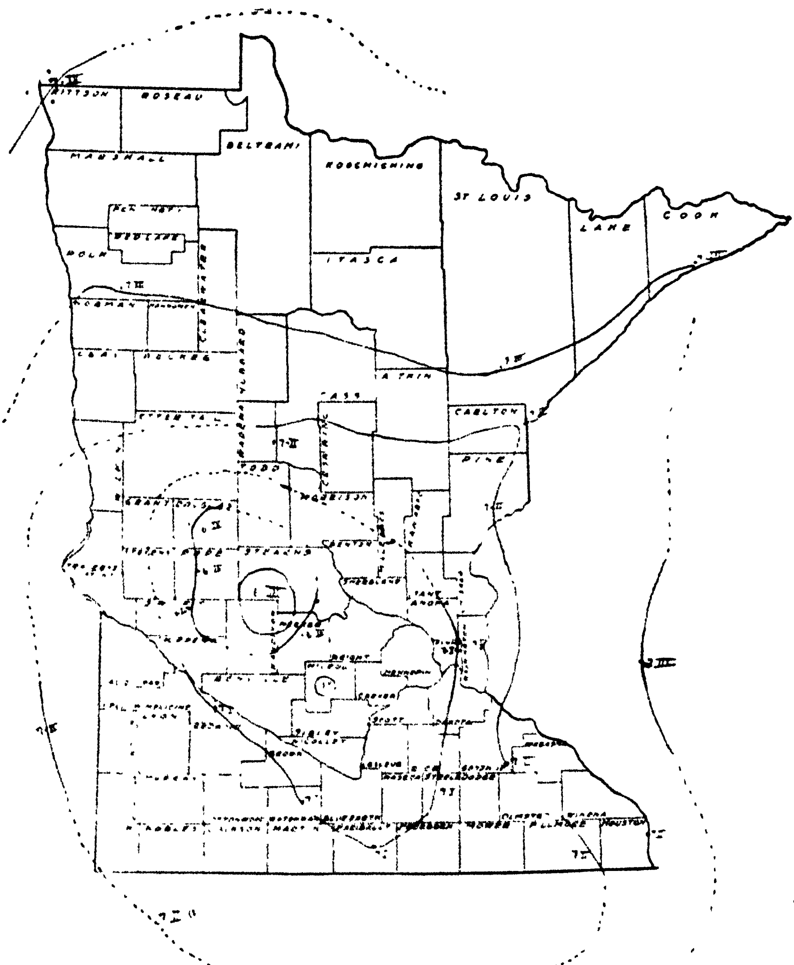

Fig. 12.—*Toxoptera graminum*, approximate dates of maximum infestation, Minnesota, 1926. Roman numerals indicate the week, Arabic numerals the month; *e. g.*, 6–IV indicates the 4th week in June.

In looking for unusual weather associated with the outbreak, we find a rather mild winter, a very windy and dry spring and a dry and cool early summer. The mild winter is of obvious importance if we assume the species hibernated here. The windy spring is equally important

if we assume it migrated from the usual hibernating regions. In looking over weather bureau daily maps, from April 15 to May 15, we find two periods, April 19–20 and May 4, 5 and 6, during which the wind blew strongly and uniformly straight north from known infested territories; and one April 29–30 on which it blew northeast. On looking over similar records for 8 years back no other such windy spring was found. At different stations in the path of the wind the total wind movement during each period was from 500 to 1800 miles. The history of the green bug in other places shows that it reaches its greatest numbers in regions which are dry during the height of its greatest reproduction period. The normal rainy Minnesota June evidently offers a severe handicap. The cool June of 1926 may also have restricted the activities of aphid enemies.

Any theory concerning the origin of the infestation must explain especially the distribution of the aphids and their early development in west central Minnesota. Grain is not up there until about April 20th, and there could not have been more than five generations after this to the peak of the outbreak. Hence, the aphids must have arrived early, of if they came later, arrived in large numbers. The aphids could hardly have wintered alive, as a temperature near 0°F. kills all of them. Even if some were sheltered under snow where temperatures remain above this mark, it seems impossible that they should live five or six months under such conditions. However, this possibility is being investigated. The two theories given most attention are that they wintered in the north, as eggs, and were favored by a dry season and that they migrated in on the wind from Oklahoma where we know they wintered. The periods of south wind could account for the western Iowa, western Minnesota and North Dakota centers, and the southwest wind spell for central Iowa, eastern Wisconsin and upper Michigan centers.

The points in favor of the two theories of origin may be summarized as follows:

Overwintering in Minnesota

1. The species has been shown to winter as eggs in Indiana (U. S. Bu. Ent. Bul. 110) and could probably withstand a mild winter in Minnesota.

2. A few *Toxoptera* were taken in 1925 at St. Paul.

3. The eggs may have overwintered in favorable localities and migrated locally.

4. A flight of 800 miles for this insect seems almost impossible.

MIGRATION

1. The sexes were not produced outdoors in 1907 and 1926 in Minnesota and the fall of 1925 was much less favorable than those two years, due to near-zero weather late in October.
2. Should eggs be deposited they would probably hatch late in April in this latitude. The stem-mother (recorded as wingless) would have to mature and produce young, which would also have to mature, before migrants could invade the fields.
3. The first infestation was not in the mildest part of the state, but in a territory of more sévere winters and high spring winds.
4. Winds having the right date, direction and velocity to explain infestations occurred.
5. The possibility of the insect traveling so far does not appear altogether incredible. We have many records of frail insects being wind-borne, including observations on the green bug itself in U. S. Bu. Ent. Bul. 110, and the species can live several days without food at temperatures around 50°F.

From the present data it appears that the migration theory is more probable, yet we are far from being entirely satisfied with it. Further investigations on the ecology of this insect are being carried on.

PRESIDENT ARTHUR GIBSON: Next is a paper by F. A. Fenton.

WINTER SURVIVAL OF THE COTTON BOLL WEEVIL AT FLORENCE, S. C.

By F. A. FENTON and E. W. DUNNAM, *Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

From 1922 to 1926, an average of 3.27 per cent of cotton boll weevils survived the winter in various types of protective shelters at Florence, South Carolina. Practically all weevils issuing from hibernation before cotton was available as a food plant died, the average longevity at this time being 5.64 days. Of weevils emerging from winter quarters after cotton came up, and placed in field cages on young cotton plants, a great majority died before these started to square, their average longevity under these conditions being 8.12 days. Weevils emerging at or after the time when squares were developed on cotton plants were longer lived in these same field cages than those emerging prior to this time, the average longevity for males being 16.28 and for females, 13.42 days. The maximum longevity at this time was 66 days for males and 46 for females. According to trap crop records and field counts, weevils continued to enter the cotton fields for three to four weeks after the first squares formed, or until about the time the first blooms appeared. In 1925, 90.01 per cent of the surviving

weevils had emerged in all cages at the time cotton began to square, 73.04 in those in the woods, 90.37 in those in the field, and 47.01 per cent in the trap crops. That year emergence in the hibernation cages located in the woods corresponded very closely with that in the two trap crops after May 14. In 1926, 98.03 per cent of the weevils had emerged in all the hibernation cages when cotton began to square, all in those in the woods, 97.91 per cent in those in the field, and none had been collected in the trap crops. The emergence of the weevils in the hibernation cages is called the "total emergence," and that in the trap crops the "effective emergence," since the latter represents those weevils that emerge late enough to find cotton. Trap-crop records and field counts for the two years indicate that there may be a considerable migration of weevils to cotton fields after first square production, although this may actually represent a small percentage of the total survival for that year. The use of the trap crop in determining the rate of "effective emergence" of the weevil from hibernation is more reliable and more representative of field conditions than is that of the hibernation cage.

One of the most remarkable things about the life history of the cotton boll weevil is the fact that, although native to tropical America, it is able to pass the winter successfully in the northern edge of the cotton belt, hundreds of miles north of its original habitat and under radically different climatic conditions. This paper presents data that show how this species survived the winters at Florence, South Carolina, from 1922–23 to 1925–26. The writers have made most of the observations but have also used some hibernation data obtained prior to their arrival at Florence in the spring of 1924. Records before this time were made by R. W. Moreland. All experiments have been under the direction of B. R. Coad, in charge of cotton insect investigations, U. S. Bureau of Entomology, Tallulah, Louisiana.

Method of Procedure

Weevils were collected from cotton fields in the fall and placed in lantern globe cages and battery jars where they were fed on cotton squares until needed. At the end of each week, or at the date it was decided to install these in hibernation, they were counted and released in the cages. The latter were of the standard type specified by the Delta Laboratory at Tallulah, Louisiana, being four feet in all three dimensions with rust-proof screen wire. There were usually four series of cages for use in determining various points about weevil hibernation, as follows: One consisted of weevils released in pine straw at weekly intervals from early September until the first killing frost, to find out the effect of date of installation on percentage of survival. In the second series, weevils were released in cages with various types of debris, to determine the effect of shelter on survival. In this series the following materials were used: cotton stalks alone, or in combination with pine

straw, pine straw alone, cornstalks, Spanish moss, oat straw, sawdust, or with no other protection than the cage itself. In the third series different numbers of weevils—25, 50, 75, etc., up to 500 to a cage—were released to determine the effect of numbers on survival. The fourth series had cages installed at weekly intervals in the field and also in the woods to determine the effect of out-door environment on survival. Each cage was examined daily from March to July 15 and the number of weevils which issued recorded.

Per Cent of Survival

In 1923, 442 weevils survived out of a total of 4,000 placed in hibernation cages during the fall of 1922, or there was an average survival of 11.05 per cent. The survival in other years was as follows· 1924, 75 out of 21,617, or 0.34 per cent; 1925, 1,262 out of 19,427, or 6.49 per cent; 1926, 102 out of 12,425, or 0.82 per cent. Taking the four years together, some 57,469 weevils were collected at various intervals during the fall from September to November inclusive, and placed in various types of protective shelters. Of these, 1,881 survived, the weighted average survival being 3.27 per cent (Table 1).

Rate of Emergence

Observations on the emergence of the weevil were commenced in March and continued up to July 15. During this period for the four years, 400 weevils issued during March, 786 in April, 549 in May, 144 in June and 2 in July. In 1923 and 1924, emergence was heaviest during May, but in 1925 and 1926, the largest number issued during April (Table 2).

In three of the four years, emergence in March was comparatively light, being 4.9 per cent of the total in 1926, 8 in 1924 and 9.04 in 1923. In 1925, however, it was 27.65 per cent of the total. The percentage of the total emergence in April also varied during this period from 33 48 per cent in 1923 to 53.92 in 1926. In May it varied from 20 52 in 1925 to 51.8 in 1923, and in June at was 7 6 in 1925 and 16 in 1924. July 1, 1925, two weevils issued from the hibernation cages, this representing 0.15 per cent of the total number surviving. Averages for the four years show that 12.40 per cent emerged in March, 41.86 in April, 35 68 in May, 10.01 in June and 0.15 in July (Table 2).

Per cent of Emergence Before Cotton Plants Were up

Cotton in this section was up April 17, 1923, April 24, 1924, April 21, 1925 and April 30, 1926. Therefore, 21.26 per cent of the weevils had emerged from hibernation before cotton came up in 1923, 40 per cent in 1924, 50.63 per cent in 1925 and 58.82 per cent in 1926.

Longevity of Overwintered Weevils Before Cotton Came up

In order to determine the longevity of weevils issuing before cotton came up in 1925 and 1926, as they issued from the trash in the hibernation cages they were marked with different colored dyes and replaced. When seen again, a second mark was made, and so on each day as long as they lived and were recovered.

There were 524 weevils which emerged in the field cages prior to April 21, 1925, the date at which cotton first came up. Of these, 332 or 63.23 per cent, were recovered at various dates after they were first seen. Some were observed the following day only, while others disappeared for short periods, reappearing from time to time. The longevity ranged from 1 to 52 days and averaged 5.64. In the cages in the woods, 94 issued before April 21, 64 of which, or 68.08 per cent, were seen from one to six times after the first record of their emergence from hibernation. Here the range in the length of life varied from 2 to 23 days, with an average of 4.90. For all cages in 1925, the average post-emergence longevity before cotton came up was 5.52 days.

In 1926, 46 weevils emerged in the field cages prior to April 30, when cotton was first up. Thirty of these, or 67.39 per cent, were recovered after their first emergence. In the cages in the woods 12 of the 14, or 85.71 per cent, emerging during this period lived longer than one day. For both series the maximum longevity was 23 days and the average 6.86. The average in the field cages was 5.89 and in those in the woods, 10.07 days.

The average longevity in the hibernation cages for the two year period was 5.64 days (Table 3). During both years a few weevils issuing before the appearance of cotton above ground lived long enough to feed upon the young plants, but they all died in the field cages shortly thereafter.

Per Cent of Emergence Before Fruiting of Cotton

From the time cotton comes up until it starts to develop blossom buds or "squares," the weevil cannot reproduce and has to feed on the leaves, tender stems and leaf buds. Since the plants do not square until late May or usually early June in this section, this period extends from five to seven weeks after cotton first comes up. The weevils still continue to emerge from hibernation during this time. In 1923, the first squares appeared June 14 and 99.09 per cent had emerged by this date. For the other years, the per cent of emergence at date of first square formation was as follows: 1924, 97.33 on June 10; 1925, 90.01 on May 29; 1926, 98.03 on June 7.

LONGEVITY BEFORE FRUITING OF COTTON

In order to determine the longevity of weevils emerging from hibernation after cotton came up but before it developed squares, they were removed from the cages on the same day that they emerged, and placed in large field cages over young plants. As a check, a similar series was under observation in the insectary in tumblers, cotton leaves and leaf buds being used as food. In 1925, 165 weevils were released in field cages at weekly intervals from April 23 to May 28. Ninety-seven of these emerging from April 23 to May 9 were all dead before cotton began to square. Of the remaining 68, released from May 14 to 28, from 62 to 90 per cent were dead by the time cotton began to fruit. The average length of life was 8.01 days. In 1926, 27 weevils were released from April 17 to 28 in field cages and 96.29 per cent were dead June 7 when squares were first formed. The average longevity for this year was 8.81 days. The maximum longevity for the two-year period was 40 days and the average from 192 records was 8.12.

In 1925, 125 weevils were released in tumblers and bell jars in the insectary at intervals from April 22 to May 25. Fifty-five of these, or 44 per cent, were dead when cotton began to fruit. The average longevity was 14.56 days. In 1926, 38 weevils were released in tumblers from April 29 to June 4, and 10.52 per cent were dead June 7. The average longevity was 12.21 days. The maximum length of life for the two year period was 40 days and the average from 163 records was 14.01 (Table 4).

The greater average longevity of weevils in the insectary over that of those in the field cages indicates that conditions in the former were more favorable for the weevil. Experiments at Tallulah and elsewhere have shown that there is a difference in temperature, humidity, evaporation and amount of sunlight in a wire-screen cage as compared to these in the field, but these cages represented a nearer approach to natural conditions than the tumblers in the insectary. Later on in the season, as soon as the cotton plants were larger and were fruiting, it was possible to keep the weevils alive much longer than before in these same cages.

PER CENT OF EMERGENCE AFTER COTTON FRUITS

In 1923, 0.9 per cent emerged from the hibernation cages after the first squares formed, in 1924, 2.67; in 1925, 9.99; and 1.97 in 1926. The last weevil emerged June 19, 1923, June 25, 1924, July 1, 1925 and June 22, 1926.

LONGEVITY AFTER COTTON FRUITS

While the weevils were very short lived in the field cages when fed on cotton prior to and often just after the plants started to square, con-

ditions were soon reached by the plant favoring these insects. There was a rapid increase in plant height and total leaf area, giving shade and protection from the sun, as well as the production of squares upon which the weevil naturally fed. The average longevity of males after square production was 21.55 days in 1924, and 13.46 in 1925. For the two-year period the maximum was 66, the minimum 2 and the average 16.28 days. The average longevity of the females in 1924 was 16.45 days, and 11.51 in 1925. For the two-year period, the maximum was 46, the minimum 2 and the average 13.42 days.

Comparison of Weevil Survival in Field and Woods

In 1925 and 1926, a series of hibernation cages was under observation in a pine woods flat in order to determine whether the protection afforded by the trees and undergrowth would have any effect upon the number of weevils surviving the winter. It was found that there was a difference in the percentage surviving in the two series of cages during the two years as follows: In 1925, 7.6 per cent survived the winter in pine straw trash in the field and 10.98 per cent in the woods; in 1926, the survival in the woods was 0.42 and in the field 1.2 per cent. Thus, one year, more weevils survived in the field cages and the other year more in the woods cages. It is therefore difficult at the present time to determine which of the two locations is representative of what actually happens.

Comparison of Emergence in Field and Woods Cages

In 1925, the emergence from the field cages by monthly periods was as follows: March 31, 23.7 per cent; April 30, 65.18 per cent; May 31, 94.00 per cent; and June 17, 100 per cent. That year the rate of emergence from the woods cages was slower as is shown by the following figures: March 31, 21.3 per cent; April 30, 56.25 per cent; May 31, 75.39 per cent; and July 1, 100 per cent. In 1926, none issued from cages in either location during March; April 30, 82.35 per cent had emerged in the woods as compared to 45.83 per cent in the field. Emergence was completed May 24 in the former and June 22 in the latter. It is thus seen that in 1925 and 1926, there was a difference in the rate of emergence of the weevil from hibernation cages located in the two situations, one year field cages accelerating emergence and the other retarding it.

Migration of Overwintered Weevils to Cotton as Determined by Trap Crops

In addition to determining the rate of emergence from hibernation by the aforementioned cage experiments, we decided to find out when

weevils were actually migrating to the cotton fields in the spring, by the use of trap plants. Two small plats were planted early in April 1925. One of these was situated on the edge of a tobacco field and the other in a peach orchard. Both locations were chosen because they bordered wooded areas, where heavily infested cotton had been the year before and were isolated as far as possible from other cotton fields. The first of these trap crops comprised a tenth of an acre and was about 200 yards from the nearest cotton. The second had four rows, each approximately 50 feet long and was at least one-half mile from the nearest cotton. All plants were carefully examined every morning except Sunday, and if any weevils were found, they were removed, counted, and the sex determined. A total of 134 were collected from both plats from May 14 to July 6. Of these, 63 were removed by May 29, at which date the oldest plants were beginning to develop blossom buds. This represented 47.01 per cent of the total emergence in these plantings at a time when there was an average of 0.035 squares per plant On June 15, when there was an average of 1.6 forms per plant, 76.11 per cent of the total emergence had been recorded in these plats (Table 5).

Weevil counts made in different fields in widely separated localities around Florence showed a slight but steady increase in the weevil population from week to week from the time cotton was thinned up to the appearance of the earliest first-generation weevils. This increase can be accounted for by the fact that overwintered weevils were still coming into cotton from hibernation, a fact which checked up with trap-crop records

The trap-crop records show that in 1925 there was a considerable emergence after plants began to fruit and also that there were two distinct periods when large numbers of weevils were leaving hibernation and entering cotton fields, namely, from May 14 to May 26, and from June 11 to June 22. Another interesting fact is that while these insects had been emerging from hibernation cages ever since March 6, none were found in either plat until May 14 or 15, in spite of the fact that cotton in these was up by April 23.

In 1926, two similar plats were under observation but the emergence was so light that few data were obtained. In one planting no weevils were found and in the other, four from June 24 to June 30. In both years emergence was mostly over by June 30 at about the time the first blooms appeared.

Comparison of Emergence as Recorded by Hibernation Cages with That in Nature as Determined by the Trap Crop

In 1925, weevils issued from hibernation cages in the woods and were collected from the two trap crops on about the same dates after May 14. On the other hand, emergence in the field cages did not check up with either of the above after this date. During that year, 90.01 per cent of the surviving weevils had emerged from all cages when cotton began to square, 73.04 per cent in those located in the woods, 90.37 per cent in the field and 47.01 per cent in the trap crops. In 1926, 98.03 per cent had emerged in all hibernation cages when cotton began to square, all

Table 1. Survival of Overwintered Weevils at Florence, S. C., 1922–1926

Year	Number of weevils installed	Number of weevils survived	Per cent of weevils survived
1922–23	4,000	442	11.05
1923–24	21,617	75	0.34
1924–25	19,427	1,262	6.49
1925–26	12,425	102	0.82
1922–26	57,469	1,881	3.27

Table 2. Number and Per cent of Surviving Weevils Emerging by Months at Florence, S. C., 1923–26

Year	March		April		May		June		July	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
1923	40	9.04	148	33.48	229	51.80	25	5.65		
1924	6	8.00	27	36.00	30	40.00	12	16.00		
1925	349	27.65	556	44.05	259	20.52	96	7.60	2	0.15
1926	5	4.90	55	53.92	31	30.39	11	10.78		
Total and average	400	12.40	786	41.86	549	35.68	144	10.01	2	0.15

Table 3. Longevity of Overwintered Weevils Emerging Before Cotton Came Up, Florence, S. C., 1925–26

Year	Total number of weevils emerged before cotton came up	Maximum post-emergence longevity	Total number weevil days	Average post-emergence longevity
1925	618	52 days	3,416	5.52 days
1926	60	23 "	412	6.86 "
1925–26	678	52 "	3,828	5.64 "

Table 4. Longevity of Overwintered Weevils in Cotton Before Fruiting, Florence, S. C.

Year	Number of records		Maximum days longevity		Number weevil days		Average days longevity	
	Field	Insectary	Field	Insectary	Field	Insectary	Field	Insectary
1925	165	125	37	38+	1,322	1,820	8.01	14.56
1926	27	38	40	40+	238	464	8.81	12.21
1925–26	192	163	40	40+	1,560	2,284	8.12	14.01

TABLE 5. DAILY COLLECTIONS OF WEEVILS IN TRAP CROPS, FLORENCE, S. C., 1925

Date	Number weevils collected	Accumulated emergence	Per cent of emergence	Average number of squares per plant
Apr. 23 to May 13	0	0	0	0
May 14	9	9	6.71	
May 15	5	14	10.44	
May 16				
May 18	7	21	15.67	
May 19	2	23	17.16	
May 20	2	25	18.65	
May 21	9	34	25.37	
May 22	7	41	30.59	
May 23	9	50	37.31	
May 25	8	58	43.28	
May 26	3	61	45.52	
May 27	1	62	46.26	
May 28				
May 29	1	63	47.01	0.035
May 30	1	64	47.76	
May 31				
June 1	4	68	50.74	
June 2	5	73	54.47	0.09
June 3	2	75	55.97	
June 4				
June 5	1	76	56.71	
June 6	1	77	57.46	
June 8	2	79	58.95	0.49
June 9	4	83	61.94	
June 10				
June 11	4	87	64.92	
June 12	2	89	66.41	
June 13	2	91	67.91	
June 15	11	102	76.11	1.6
June 16	8	110	82.08	
June 17	3	113	84.32	
June 18	6	119	88.80	
June 19	1	120	89.55	
June 20	3	123	91.79	
June 22	5	128	95.52	
June 23	1	129	96.26	
June 24				4.4
June 25	3	132	98.50	
June 26				
June 27				
June 28				
June 29				
June 30				
July 1				8.3
July 2	1	133	99.25	
July 3				
July 4				
July 6	1	134	100.00	

had issued in those located in the woods, 97.91 per cent in those in the field, and none had been collected in the trap crops.

The emergence from the hibernation cages is called the "total emergence" and that in the trap crops the "effective emergence." The latter represents those weevils that issue from hibernation late enough to find cotton before dying of starvation or other causes. It has been found that the rate of emergence of weevils in hibernation cages varies in different years according to the location of the cages and to some extent with the type of shelter in the cage. As a result the data secured by means of the trap crops is considered more reliable because it actually represents field conditions.

PRESIDENT ARTHUR GIBSON: We will now listen to a paper by J. M. Robinson.

THREE YEARS OF BOLL WEEVIL CONTROL ON ONE TWENTIETH ACRE PLOTS, WITH VARIOUS RATES OF FERTILIZERS

By J. M. ROBINSON, *Auburn, Ala.*

(Withdrawn for publication elsewhere)

MR. W. E. HINDS: Possibly Professor Robinson might have brought out a little more clearly that this was an old cotton farm where the fertility of the soil had been almost exhausted, as I am sure you could see from those unfertilized rows. (Exhibited in lantern slides.) Under those conditions and under a dry season with a high degree of moisture control, there was little room for poisoning to show a normal profit. The figures there as to the gain from poisoning in a season of average rainfall will probably be about the average for the entire cotton belt, and as your productive capacity increases, the saving from poisoning also increases and becomes more profitable, but one of the most interesting things to me in the figures shown on the screen was the absolute proof that in a dry season there is no cross feeding from one row to another, even with rows planted three and a half feet apart, as I think was the distance in this case, where the next row had as high as 1500 or 2000 lbs. of fertilizer to the acre. That unfertilized row, as you noticed, was very striking indeed.

PRESIDENT ARTHUR GIBSON: The next paper is by L. L. Huber and C. R. Neiswander. Mr. Huber read the paper.

THE EUROPEAN CORN BORER AND ECOLOGICAL HABITATS

By L. L. HUBER and C. R. NEISWANDER, *Ohio Agricultural Experiment Station, Wooster, Ohio*

ABSTRACT

This paper constitutes a report of one phase of the European corn borer (*Pyrausta nubilalis* Hübn.) project in Ohio. The information contained herein consists of the using of vegetative types as indices of certain atmospheric and edaphic factors that are thought to greatly influence the behavior of the corn borer. An attempt is made to show that up to the present time the corn borer has accumulated most rapidly and has occasioned most severe damage in certain restricted areas.

Since the introduction of the European corn borer (*Pyrausta nubilalis* Hübn.) into Ohio, yearly surveys have been made to determine the rate of accumulation of the insect in previously infested areas. In addition to and in conjunction with the regular survey, Dr. E. N. Transeau and Dr. H. C. Sampson of the Ohio State University conducted, during the past summer, an ecological survey of certain vegetative types in Ohio and all other regions infested by the corn borer, exclusive of New England. In this paper an attempt is made to point out the correlation between the ecological data and infestation records.

This joint survey was greatly facilitated by the generous cooperation and services of Mr. H. G. Crawford of Canada and Dr. E. P. Felt of New York. Others actively assisting in the project were Mr. E. G. Kelsheimer and Mr. J. B. Polivka of the Ohio Station.

Infestation data in Ohio since the beginning of investigational work have indicated certain areas where the percentage of infestation has been consistently high and other areas where it has been consistently low. Detailed data relative to the accumulation of the insect in areas outside of Ohio are not available, but from reliable information given by federal and state investigators and from personal observations it is known that there are regions in New York, Pennsylvania and Michigan where similar conditions obtain. (See map, Figure 13.) It is a matter of general knowledge that the infestation in the Schenectady region in New York has been and still is considered almost negligible; damage has occurred only over a few hundred acres. On the contrary, in the Silver Creek, New York, region the infestation has long since accumulated to the point where serious losses have occurred over extensive areas. Similar conditions of infestation, although less marked, exist in Pennsylvania and Michigan.

Detailed infestation data permit a more thorough discussion of the conditions in Ohio. In 1921 Federal scouts discovered the corn borer

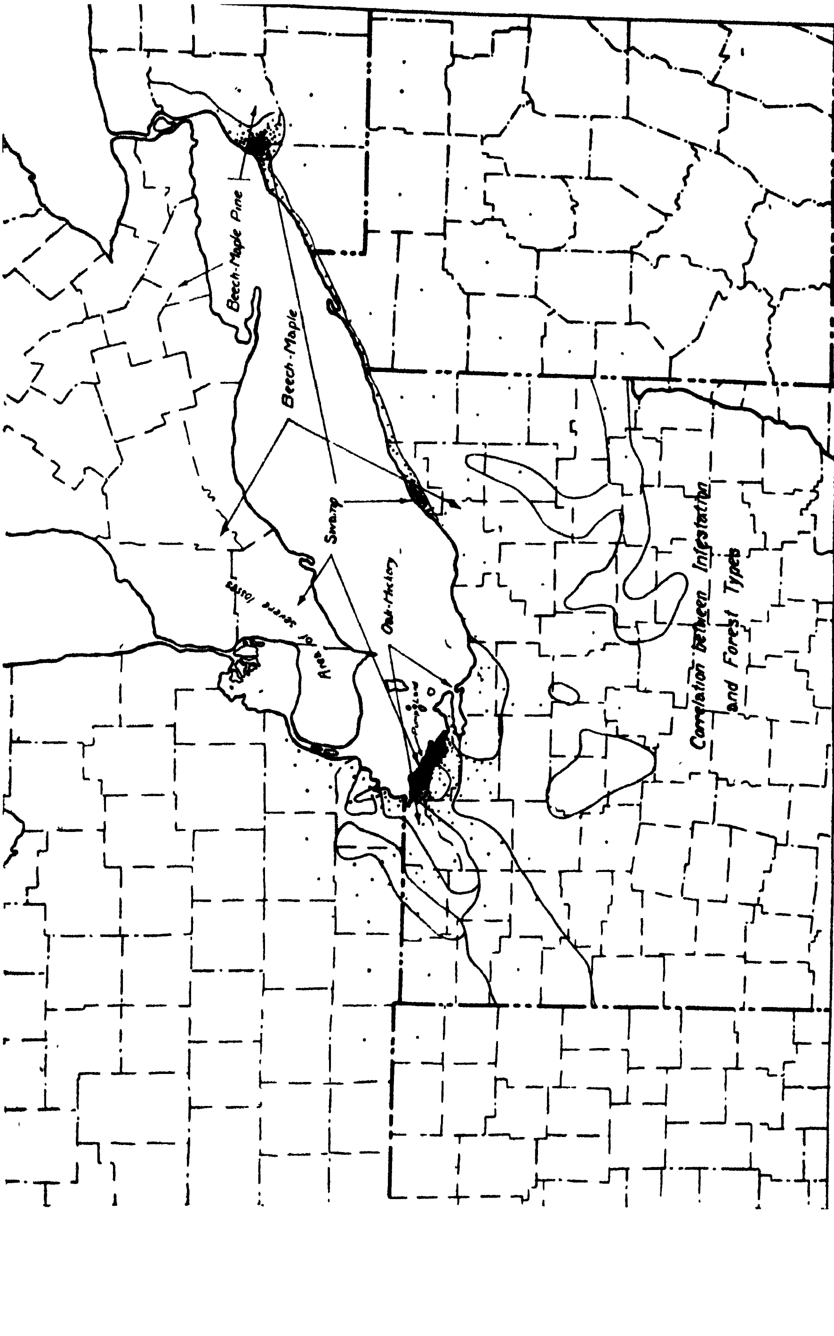

Fig. 13.—Map illustrating the correlation between infestation and forest types.

in every township along the border of Lake Erie. This territory has been scouted wholly or in part every year since 1921. The records for 1922 were meager but, even so, there was already some evidence of a tendency to accumulate in certain areas. The records for every year since 1922 have indicated a pronounced tendency for accumulation at certain points. The infestation map (Figure 13) indicates a narrow strip in the vicinity of Painesville in northeastern Ohio that has for four years maintained a consistently high infestation; whereas the adjacent area just south has had a consistently low infestation. The average borer population per acre for this narrow strip bordering the Lake is about 10,000, but the average borer population per acre for an area of equal width immediately south is not more than 400, or a ratio of 25 to 1. In northwestern Ohio a more marked contrast exists. The average borer population in the Bono area east of Toledo as compared with the average west of Toledo is in a ratio of 45 to 1. The general territory centering around Sandusky in Erie County has a somewhat similar history. The infestation in the Bono region is in a ratio of 17 to 1, as compared with the Sandusky region.

The following data will serve to point out the approximate rate of accumulation of the insect in the regions east and west of Toledo. In the Bono area the maximum borer population per acre in 1923 was about 1500; in 1924 it was about 4000; in 1925 it was about 13,000; and in 1926 it was about 80,000. However, in the area immediately west of Toledo where the infestation is of just as long duration as at Bono, there has been no such tendency to accumulate. The present maximum infestation west of Toledo is probably not more than 2000 borers per acre, as compared with 80,000 per acre to the east.

It is an undisputed fact, therefore, that up to the present time the accumulation and the degree of infestation of the corn borer has not been equal in all areas. In the six to eight years that have elapsed since the introduction of the insect the highest infestation, the most rapid accumulation and the most severe damage to corn have occurred in certain restricted regions as indicated.

According to Transeau "Our best measure of habitat conditions in a restricted region is the vegetative type." "In the present corn borer region the original forests consisted principally of three types: (1) the Oak-Hickory Forest; (2) the Beech-Maple Forest; and (3) the Swamp Forest."

"The Oak-Hickory Forest (when original) is generally found in drier areas, either because of dry climatic conditions, or because of over-

drainage, or a combination of both. The Beech-Maple Forest usually represents more moist conditions, both of atmosphere and soil. The Swamp Forest—Elm, Ash, Maple, Swamp White Oak, Pin Oak and Hickory—is typical of areas with a high soil water table and constantly humid conditions."

The purpose of the joint ecological and insect survey was an attempt to discover, if possible, an ecological index to the degree of infestation. The survey included the region from Niagara Falls to Windsor and Sarnia and from Detroit around the Lake, to Buffalo and Schenectady. It was noted that the Swamp Forest is dominant over the extreme western portion of Ontario, a part of northwestern Ohio, and the territory directly adjacent to the Lake in northeastern Ohio, Pennsylvania and New York. Closely associated with the Swamp type is the Beech-Maple or the Beech-Maple-Pine types which abound on the uplands, the latter type being dominant in eastern Ontario and in the Silver Creek region. The Schenectady area, not shown on the maps, is primarily a Beech-Maple habitat, although the Swamp type abounds over two or three hundred acres in the river valley. The third type of forest, or Oak-Hickory, dominates the Sandusky region, and the area immediately west of Toledo. In this connection, however, it is well to point out that there may be local or restricted habitats of a different nature within the general habitat regions, as indicated on the map. For example, within the Oak-Hickory habitat about Sandusky there are restricted Swamp areas.

The following map (Figure 13) illustrates the extent of correlation of forest types with infestation records. It is shown here that the most rapid accumulation of the corn borer has occurred rather uniformly in regions where the Swamp Forests are dominant and where Beech-Maple is the upland type. On the other hand the least rapid accumulation has occurred on the higher lands where the Oak-Hickory or Beech-Maple-Pine types are dominant. Furthermore it may be of interest to note that the heaviest infestation in Ohio occurs in an area that consists largely of reclaimed swamp lands.

The above correlation is offered here only as information; it is not explanatory. The explanation is the subject of present and future research. Unlike many other ecological studies, no detailed meteorological records are involved. This study consists in the using of vegetation types as indices of certain atmospheric and edaphic factors which have been at work for a long period. Evidently the same factors that have determined the type of vegetation in restricted areas are also

influencing the accumulation of the corn borer in similar restricted regions. Inasmuch as the survey is still incomplete, no definite conconclusions can be drawn. But if the behavior of the insect, since its introduction into the areas mentioned, is any criterion of its future behavior, then it is not too much to expect that its control will be more difficult in some areas than in others. And the sooner we know where these areas are the more intelligent will be our attack.

President Arthur Gibson: The next is a paper by L. S. McLaine and H. G. Crawford.

Mr. McLaine read the paper.

THE STATUS OF THE EUROPEAN CORN BORER IN CANADA (1926)

By L. S. McLaine and H. G. Crawford, *Entomological Branch, Ottawa*

Abstract

During 1926 the European corn borer, *Pyrausta nubilalis* Hübn., spread in Ontario into sixty additional townships. The infested area now covers approximately thirty-five thousand square miles. The most easterly infestation is 375 miles from the original outbreak in Elgin county, and the most northerly 250 miles from the same district. In addition two infestations widely separated have been uncovered in the province of Quebec, both being due to natural spread.

With the exception of a small area, where much extension work has been carried on, there has been a decided increase in the amount of infestation in Ontario. The 400 square mile area severely devastated in Essex and Kent Counties in 1925, increased to 1200 square miles in 1926.

The infestation in Quebec is exceedingly light.

Control operations are now being carried out in the eight most heavily infested counties in Ontario, under the supervision of the provincial authorities.

During the past season the European corn borer has continued to spread into new territory until now it infests practically the entire corn growing districts of the province of Ontario and has also invaded the province of Quebec.

Although this past summer has been regarded as one of unusual coolness, greater precipitation, and of shorter duration than the average, this pest has spread over more territory than was the case last year. One or more collections of European corn borer larvae were made in sixty additional townships in Ontario last season as compared with twenty-five in 1925 and five in 1924. The infested area in this province may be said to extend from the Quebec boundary on the east, to Lake Huron and the Detroit River on the west, and south of a line from the city of Ottawa to Parry Sound on the north, and covers roughly thirty-

five thousand square miles. At the present time 333 townships are infested or under quarantine, this number will be increased later in the season when the quarantine regulation is revised and townships not found infested but adjacent to infested ones are included for economic reasons. The most easterly infestation found this past season is about three hundred and seventy-five miles from the original outbreak in Elgin county. Mention should be made of the isolated infestation found at North Bay on Lake Nipissing in Nipissing county. This outbreak is of particular interest on account of its northern position, being approximately two hundred and fifty miles north of the original outbreak at St. Thomas. From the information available it would appear that with the exception of the outbreak at North Bay, the increase in the infested area is due to the natural spread of the insect. As regards North Bay, the infestation is undoubtedly due to infested corn being carried or shipped from the infested area. Although every effort has been made to prevent the illegal shipping of corn, the financial returns were apparently too strong for unscrupulous individuals to resist, as early table corn is sold at a good premium in the northern districts.

The outbreak in Quebec which occurs at two different points is due to natural spread. One of these occurs in two townships in Hull County and one in Papineau County just north of and across the Ottawa river from the city of Ottawa. The second outbreak is in south western Quebec just north of the state of New York, and is due undoubtedly to spread from the infestation which has occurred in northern New York. About two hundred square miles are involved in the three townships in the Hull area and five hundred and fifty square miles in the south western area which includes portions of Chateauguay, Huntingdon and St. Johns counties.

Intensity of Infestation

For the fourth successive year certain definite points were selected throughout the infested area to determine the increase or decrease in the amount of infestation. The points are fixed and three hundred corn stalks in each of the five corn fields nearest to the so called "point" are examined. Only the percentage of stalk infestation was taken, time would not permit the recording of the larval population per stalk. Records were taken at eighty-nine different points in 1926.

The locality points selected may be divided into two distinct groups, first those on a series of three concentric circles, seven, fifteen and thirty miles respectively from Union as a centre, which was the centre of the initial and severe infestation, and known as circles Nos. 1, 2 and 3;

and second, points selected at different localities in various infested counties.

The average stalk infestation in circle No. 1 (seven miles from Union) showed a decrease in both 1925 and 1926, a reduction of from forty to thirty per cent occurring this year. It should be noted that in this area intensive educational and demonstration campaigns have been carried on, sweet corn as a crop has been practically discontinued and the greater portion of the main corn crop is ensiled. In circle No. 2 (fifteen miles from Union) there has been an increase of from thirty-two to thirty-nine per cent; and in circle No. 3 (thirty miles from Union) the stalk infestation has increased from eleven to twenty-nine per cent. The three great corn growing counties continue to show a marked increase, Kent increasing from fifty-three to seventy-nine per cent; Essex from thirty-eight to eighty-three per cent and Lambton jumped from five to thirty-four per cent, north-west Middlesex county which adjoins Lambton, showed an increase of from four to twenty-nine per cent.

In the paper presented last year it was stated that in an area covering approximately four hundred square miles along the Kent-Essex counties line, the corn was a complete loss, in 1926 this area was increased to approximately twelve hundred square miles. Extensive loss also occurred westward from this area to the Detroit river and northward into the southern part of Lambton county.

The European corn borer is also increasing rapidly in numbers in several other counties; mention may be made of Welland which was first found infested in 1920; for a number of years the increase was by no means rapid, but this past season it rose from twelve to twenty-eight per cent.

Prince Edward County is an isolated peninsula extending into Lake Ontario about one hundred miles east of Toronto; it is a large corn growing county and ninety-five per cent of the crop is grown for canning purposes. A very light infestation was discovered in this county in 1924; this year the general average was about two per cent, but in some fields as high as ten per cent infestation was found. Apart from the districts mentioned the European corn borer infestation remains still so light that no serious damage was done in 1926.

The infestation in the two infested sections in the province of Quebec is very light at the present time, being much less than one per cent.

Control

In the most heavily infested sections of Kent and Essex counties there has been a very decided decrease in the amount of corn acreage

planted and from the information available at this time it would appear that the acreage would be still further reduced in 1927.

The actual control operations in the province of Ontario are under the jurisdiction of the Provincial Department of Agriculture. On July 20th, 1926, regulations were passed under the European Corn Borer Act of 1926. In accordance with these regulations it is the duty of every person growing corn in the counties to which the Act has been made effective, to adopt such methods in the growing of corn and in handling the land and the remnants of the crop as will most effectively control the corn borer. The regulations further define as to the action that must be taken by the owner or occupier of the land in handling the crop, crop remnants, stored corn, and the tillage of the soil for crops following corn, etc. Inspectors are appointed to see that the regulations are carried out and if an occupant neglects or refuses to carry out the instructions of the inspector, the latter may carry out the control operations, in which case the expense so incurred shall be entered on the collector's roll and be collected in the same manner as taxes. This law has been made to apply to eight counties and inspectors were appointed early in the fall to see that the regulations are being duly carried out. The counties affected are: Essex, Kent, Lambton, Elgin, Middlesex. Norfolk, Oxford, and Prince Edward.

President Arthur Gibson: We have one more paper on the European corn borer.

THE EUROPEAN CORN BORER IN WEEDS AND TRUCK CROPS IN OHIO

By C. R. Neiswander and L. L. Huber, *Ohio Agricultural Experiment Station, Wooster, Ohio*

Abstract

This paper gives the results of an experiment in which corn borers, *Pyrausta nubilalis* Hübn., were reared on plants other than corn, together with the statement of field records on the number of larvae found in weeds in heavily infested corn fields.

Investigators studying the European corn borer (*Pyrausta nubilalis* Hübn.) in Ohio are continually being asked the question why at the outset the government did not forbid the growing of corn for a year or two in the infested area around Lake Erie and thus effectively exterminate the borer. In answering a question of this kind entomologists have been hampered somewhat by lack of data although all were convinced of the futility of such a procedure. For instance, there is no reason for assuming that the corn borer is not entering and will not continue to

enter the Ohio region each year in the same manner in which it came originally. Since the infestation across Lake Erie has increased enormously the probability is great that the number of moths entering the United States each year is normally much greater than were those responsible for the original infestation.

A still further indication of the futility of this plan, and one with which this paper deals, is the probability that the corn borer would not be exterminated if corn were completely lacking as a source of food material. It has been demonstrated a number of times in laboratories that corn borer moths can be forced to deposit eggs on almost any plant and even on other materials. This means that if corn borer moths were unable to find corn, due to the restriction of corn growing in the infested areas by governmental action, the moths already there would most certainly deposit their eggs on other plants or other materials as they do where corn is not available as in cages. The problem then remains to determine whether any of these eggs so deposited would develop to mature moths.

Weed and Truck Crop Cage—1925

During the summer of 1925 a large cage fourteen feet by sixteen feet and seven feet high enclosed by 12 mesh wire cloth was used as a general truck and weed experimental cage. In it were grown a great variety of garden and truck crops; and most of the common weeds as well as field and sweet corn. A large number of moths were permitted to emerge within this cage and deposit eggs as they would. An examination of the plants at the height of the egg laying period showed that egg masses had been deposited on the following plants· pigweed, spanish needle, turnip, bean, radish, celery, sweet corn, field corn and gladiolus. A subsequent examination made on July 28 showed that the following plants were or had been infested: common ragweed, pigweed, smartweed, lamb's quarters, foxtail, barnyard grass, round-leafed mallow, spearmint, velvet leaf, curly dock, radish, bean, potato, red beet, tomato, celery, sweet corn and field corn. Growing promiscuously as these plants were it can by no means be assumed that the larvae developed in the plants on which they were originally deposited as eggs. But since the examination was made before any of the larvae had ceased feeding, the test shows that the larvae were able to feed in some stage of their development on the above named plants.

Subsidiary to this experiment, cages were run on individual and isolated plants of a few common species, the plants being left to stand throughout the season. Five female and five male moths had been placed

in each cage. The plants used were smartweed, pigweed, cocklebur, potato, and tomato. The number of eggs deposited on them varied from six to twenty-seven egg masses. Since the plants were not dissected or disturbed until the end of the season it could not be definitely stated that borers had made their complete development on any of the plants, but from the fact that the plants were somewhat isolated, from the nature of the injury to the plants when examined, and from the borers found when the plants were dissected, smartweed and cocklebur seem to have been satisfactory hosts. In the potato plant there were a few short tunnels but no borers were found, while in pigweed, tomato, and lamb's quarters there was no positive evidence of corn borer feeding, and the indications were that these plants did not serve as complete hosts as far as this test was concerned.

Corn Borer Host Experiment—1926

As a consequence of the above indications a further and more complete test was planned for the following season. A number of plants of the different species selected for study were grown in plots, each consisting of three rows five hills long with a seven foot interval between plots to lessen the chance of migration. The species of weeds used in the test were cocklebur, *Xanthium canadense*, giant ragweed, *Ambrosia trifida*, pigweed, *Amaranthus retroflexus*, smartweed, *Polygonum* sp., and velvet leaf, *Abutilon theophrasti*. In addition to these there was also a plot of celery, potato, broom corn, sorghum. field corn, and dahlia. As an extra precaution to prevent migration from the corn to any of these plants the corn plot was entirely surrounded by the usual type of barrier used in our corn borer experimental work.

Cylindrical wire cloth cages approximately two feet high were placed over the plants. Usually five males and five females were placed in each cage, the number included depending somewhat upon the moths available at the time the cages were started, the object being to have enough moths to produce a sufficient number of eggs for a significant record. New cages were started every few days throughout the period of the experiment. The cages were left on the plants about five days or until just before time for the first eggs to hatch. They were then removed and the egg masses and eggs counted.

In order to be sure that the larvae were living in these plants at all stages dissections of plants in all plots were made at intervals beginning July 30 or about twenty days after the first eggs were deposited. The number of larvae and the instar in which they occurred at the time of dissection was recorded in every case. Below are given charts with the

type of information taken. In order to conserve space the record of just three hosts is given in complete form.

DISSECTION RECORD OF THREE HOST SPECIES

Host	Mating date	Removal date	Eggs deposited	Dissection date	Larvae taken by instars 1st	2nd	3rd	4th	5th	6th	Total	Per cent recovered	Remarks
Smart-	7- 6	7- 9	125	7-30	8	15	9	3			35	28.0	See
weed	7- 8	7-13	1241	8- 9		2	4	5	3		14	1.1	note [1]
	7- 7	7-12	148	8-18					1	1	2	1.3	
	7-15	7-20	456	8-28						5	5	1.1	
	7-13	7-19	722	9- 6					1	6	7	0.9	
	7- 9	7-14	226	9-14						3	3	1.3	
Total			2918								66	2.26	
Giant	7- 8	7-13	860	7-30	26	9					35	4.0	See
rag-	7- 9	7-14	675	8- 9	1	3	3	1	1		9	1.3	note [2]
weed	7-13	7-19	1281	8-18				2	3	5	10	0.9	
	7-14	7-20	1211	8-30						27	27	2.2	
	7-13	7-19	661	9- 6						9	9	1.3	
	7-10	7-16	613	9-14						9	9	1.4	
Total			5301								99	1.87	
Pig-	7- 6	7- 8	335	7-30							0	0	See
weed	7-13	7-19	1000	8- 9							0	0	note [3]
	7- 8	7-13	552	8-18							0	0	
	7-15	7-20	365	8-30							0	0	
	7- 8	7-13	293	9- 6							0	0	
	7-12	7-19	277	9-14							0	0	
Total			2822								0	0	

[1] Very marked injury.
[2] A few leaves and branches wilted from injury
[3] One dead larva of 1st instar found.

It may be noted that in case of smartweed, at the time of the first dissection larvae were taken in each of the first four instars. In the second dissection they were found in the second to fifth instars and in the remaining four dissections only in the fifth and sixth. Practically the same records may be noted for the giant ragweed. This seems to show that without doubt borers lived in these two species from egg to full grown larvae. On the other hand, in case of pigweed, no borers of any instar were found in any one of the six dissections in spite of the fact that nearly three thousand eggs had been deposited upon these plants. This seems to be contrary to field records since this species is a rather common host of the corn borer in badly infested corn fields. However, the borer had been found in pigweed in the field only from the fourth

instar on, the inability to feed on it apparently occurring in the first and second instars.

In the chart below is given a compiled record of the recoveries from all hosts studied. It may be noted that smartweed and dahlia have a higher percentage of establishment than has corn, while giant ragweed is just a little below it. Cocklebur also has a comparatively high establishment record, though perhaps not as high as might be expected normally since the plants used in the experiment were small and poorly developed at egg laying time. In heavily infested corn fields this last named weed is very commonly infested.

Broom corn and sorghum are shown to be very poor hosts. Of the nineteen larvae taken from these plants during the course of the experiment none were found within the stalk, all of them occurring in the crown of the plant in early dissections or behind the leaf sheath in later ones. One tunnel was seen in sorghum but it was of small size and full of a viscous secretion. In both of these species less than one-half of one per cent of the eggs deposited were recovered as larvae and only three of these were taken as full grown larvae. This record is analogous to field records for these crops in Ohio, as to date no full grown larvae have been taken from either when grown in our experimental plots in the midst of the heavily infested area at Bono, Ohio.

The results of the experiment indicate that if eggs were deposited on smartweed, ragweed, or dahlia the borers would develop as well, and on cocklebur nearly as well as on corn. The larval mortality was high in broom corn, sorghum and celery; nevertheless a few larvae were found in several dissections of each. The remaining species studied, namely, celery, potato, velvet leaf, and pigweed seem to be of no importance as primary hosts of the corn borer as it behaves in Ohio under present conditions.

While the establishment record for the larvae on these plants as given above is low when compared to the establishment sometimes recorded in fields of corn, it must be noted that the establishment on the corn plot used as a check was also low, in a few of the cases cited being slightly lower even than that of the weeds.

Field Records

Supplementary to the experimental studies made in weeds and truck crops at the laboratory, observations were made repeatedly in the field. During the egg laying period corn borer moths were commonly seen amid weeds of different species at the margins of corn fields, pigweed, *Amaranthus retroflexus*, being quite conspicuous in these localities. In

RECORD OF DISSECTIONS MADE IN DIFFERENT HOSTS STUDIED

Host	No. of dissection dates	No. of times larvae were taken	No. of eggs deposited	Instar record of larvae taken in all directions: 1st	2nd	3rd	4th	5th	6th	Total	Per cent of recovery	Remarks
Smartweed (*Polygonum* Sp.). . . .	6	6	2918	8	17	13	8	5	15	66	2.26	Very marked injury A good host
Dahlia	5	5	3302	9	15	10	11	4	24	73	2.21	Injury very severe— A good host
Corn (*Clarage*)	6	6	1777	2	1	1	1	1	33	39	2.19	Considerable leaf injury
Giant ragweed (*Ambrosia trifida*).	6	6	5301	27	12	3	3	4	50	99	1.87	Some leaves and twigs wilted
Cocklebur (*Xanthium canadense*)	5	3	903	0	1	2	4	2	1	10	1.11	Plants not thrifty— injury in every dissection
Sorghum	6	4	2759	2	1	1	4	3	1	12	.43	Very slight injury
Broom corn	5	4	2480	3	0	0	0	2	2	7	.28	Very slight injury
Celery	6	1	2129	0	0	0	0	0	1	1	.04	
Potato	5	0	671	0	0	0	0	0	0	0	0	No traces of feeding observed
Pigweed (*Amaranthus retroflexus*).	6	0	2822	0	0	0	0	0	0	0	0	Traces of slight feeding by first instar larvae
Velvet leaf (*Abutilon theophrasti*).	4	0	364	0	0	0	0	0	0	0	0	No traces of feeding observed

spite of careful search no eggs were found on any of these plants although dozens of moths could be flushed while walking through them. During the hot part of the day the insects could be seen much more commonly here than in the corn field on the corn plants.

On August 10, 1926 field dissection of weeds for early instars resulted in the finding of a number of partially grown larvae as indicated in the chart below.

Record of Partially Grown Larvae Collected in Weeds in a Corn Field at Bono

Host	Third instar	Fourth instar	Fifth instar
Pigweed		5	2
Smartweed	2	9	7
Cocklebur	1	3	2

It is assumed that these larvae developed from eggs that had been deposited on corn, which, after feeding through the first and perhaps the second instar either crawled or were carried by their ballooning habit to the neighboring weeds.

A study was made of the percentage of weeds infested in some of the fields most severely attacked by the corn borer during the summer of 1926. In making these investigations the plants of one species were taken consecutively by the observer as he walked through the field. Later, however, due to the increased wetness of the season there was an abnormal growth of weeds, many of them being too small for tunneling. Consequently during the latter part of the year only the larger weeds were considered in the count.

An average of several counts made in an especially heavily infested and very weedy field gave the results shown in the table below.

Weed Infestation in Field No. 1

Species	No. plants examined	No. plants infested	Per cent infested
Smartweed	35	23	65
Cocklebur	35	19	54
Pigweed	60	21	35
Lamb's quarters	25	4	16

In order to determine the number of borers per acre in some of the most weedy and most heavily infested fields examinations of weeds in several square rods were made with the results given below. These fields are not cited as average fields for the heavily infested region but are merely given to show what may occur in very weedy fields. In most of the heavily infested fields studied the weeds were negligible because the fields were kept clean. The first two columns in the chart below show the stalk infestation in corn in these fields and also the borer population per infested stalk in order to correlate the number of borers

in the weeds with the number present in the corn field. Although these fields were not owned by the same man the same general type of cultivation was maintained and the weed growth was enormous.

CHART SHOWING NUMBER OF BORERS PER ACRE IN WEEDS IN THREE HEAVILY INFESTED FIELDS

Field	Corn stalk infestation	Borer population per stalk	Sq. rds. examined for weed infestation	Borers per sq. rd. in weeds	Borers per acre in weeds
1	98.2	8.2	3	14.3	2293
2	90.0	3.8	5	7.2	1152
3	81.5	3.6[1]	5	4.2	672

[1]Approximated.

That these borers will have to be considered as an important source of reinfestation is evidenced by the fact that the twenty-two hundred borers per acre in field number one, if permitted to survive, would produce approximately sixty thousand borers per acre next year or just about what the field contained per acre this year when from twenty-five to forty per cent damage occurred. That is, if all the borers within the corn stalks were killed, which is practically impossible, there would still be sufficient surviving larvae in the weeds to produce an equal infestation the following year. Incidentally it may be pointed out that clean culture is a factor in corn borer control.

CONCLUSION

1. Weeds and truck crops are not known to be hosts of the European corn borer in Ohio at the present time except in or adjacent to heavily infested fields.

2. Several species of plants other than corn are potential hosts of the corn borer should eggs be deposited thereon.

3. Some of the more heavily infested corn fields in the Bono, Ohio, area have a high weed infestation, there being as high as two thousand borers per acre in weeds alone.

4. Neither eggs nor larvae younger than the third instar have been found on or in these plants in the field, hence it is assumed that the half grown or full grown larvae found in weeds have migrated from nearby infested corn plants.

PRESIDENT ARTHUR GIBSON: The next paper is by W. E. Hinds and Herbert Spencer. Mr. Hinds read the paper.

AIRPLANE DUSTING FOR SUGARCANE BORER CONTROL IN LOUISIANA

By W. E. HINDS and HERBERT SPENCER, *Louisiana Experiment Station*

ABSTRACT

The sugarcane borer (*Diatraea saccharalis crambidoides* Grote) inflicts an average damage of about 20% on the sugarcane crop in Louisiana. No practicable plantation methods for controlling this pest have become adopted or practiced to any considerable extent by the cane growers. Insecticidal treatment with arsenicals appears to be ineffective.

The recent development of the insecticide dusting airplane has provided a practicable means for treating such a crop as sugarcane, and applications of sodium silicofluoride have given a fairly satisfactory degree of control of the borer larvae, including the first and second stages while they are feeding in the leaf roll and the older stages even after they have bored into the heart of the cane.

In the treatment of thirteen hundred (1300) acres of cane by this method in 1926, the borer infestation appears to have been reduced by 60% from a single application and where observations were made about six weeks after the treatment. This allowed time for one more generation to develop. A dosage of from fifteen (15) to twenty (20) pounds per acre was required. These results are considered very encouraging and the work will be continued in 1927.

The most important insect enemy of sugarcane in this country is the sugarcane moth borer, or cane borer as it is commonly called. The species is *Diatraea saccharalis* Fabr. Some authors add the varietal name *crambidoides*.

In general appearance, and in the type of damage inflicted, this species resembles closely the larger corn stalk borer (*Diatraea zeacolella*) which attacks corn, sugarcane and some grasses but the latter species occurs through a much wider range in the Gulf States than does the genuine cane borer. There are at least three other species of Diatraea which occur in Louisiana and may be mistaken for the sugarcane borer. The larva also bears a rather close resemblance in size and in appearance to the European corn borer (*Pyrausta nubilalis*).

The sugarcane borer attacks sugarcane primarily, but is also a serious pest on corn and sorghum and frequently attacks rice, Johnson grass and several other species of large-stemmed, wild grasses growing within its range of distribution.

The problem of controlling the sugarcane borer has been under nearly continuous investigation for more than thirty years. In this time a great deal has been learned about the species but no measure of artificial control that has been previously recommended has become adopted and practiced to any considerable extent by the cane growers. The problem of control is, therefore, practically as wide open for further investigation as it has ever been. At the present time it seems that

reasonably practicable and economical control measures must be found in the near future if the cane-growing industry is to be preserved in the United States.

A brief survey of the developmental stages of the insect and a brief description of its work may aid in giving a clear understanding of the nature of the problem and the difficulties involved. The eggs are laid in batches numbering up to 50 or more on either the upper or lower surfaces of the leaves and usually upon leaves that are quite mature and at a point where the surface approaches a horizontal position. These eggs hatch usually in from 5 to 9 days. They are subject to a high degree of parasitization by *Trichogramma minutum*, especially after corn has become mature and the parasites transfer their attention from the eggs of the corn earworm and the tomato horn-worm to the eggs of the cane borer.

Upon hatching the young larvae make their way as quickly as possible to the leaf roll of the growing corn, cane or other host plant. It appears that it is necessary for these larvae to find this tender leaf tissue to enable them to develop through the second instar, but after that time they are capable of boring into the stalk. The work of the young larvae in the leaf roll becomes very conspicuous as the leaves develop, showing as minute perforations extending usually entirely through the tissue of the leaf and arranged frequently in a row of 4 or more holes arranged in a straight line and at uniform intervals apart, across the blade of the leaf. This characteristic feeding work of first stage larvae may be found upon both corn and cane and marks plainly the stalks where the initial infestation occurs. The larvae usually spend at least a week thus feeding within the shelter of the leaf roll. As they become larger they gradually work their way down the stalk making usually more than one burrow during the period of development from third to fifth instars. The full-grown larvae occur usually in a portion of the stalk that is quite mature. Their work in this stage is naturally most extensive and may extend into two joints of the corn or cane. When ready to pupate the larva prepares the exit hole for the moth, closes this with a wad of coarse frass, then retires downward usually into its burrow where it forms a slightly specialized cell for pupation. The pupal stage is passed in about a week and the moth emerges at night, or during dusk.

The extreme effect of borer damage to cane may extend to complete destruction of the crop. This is uncommon but occurred in a number of localities in 1925. Such fields were not cut and must have sheltered large numbers of full-grown larvae through the hibernation period.

There is a definite difficulty in applying insecticides to a crop like full-grown sugarcane. Such treatment is called for, as a rule, only after the first of August at which time cane is usually at least 6 ft. high. No ground machinery or even hand guns can be used readily in such a crop. The stalks commonly overlap across the rows, and it is impossible to get machinery through such a field.

However, during recent years, the development of airplane dusting for boll weevil control has provided a method for distributing dust poisons on crops which cannot be treated otherwise. The initial effort to control the cane borer by means of calcium arsenate dusting from airplanes was undertaken at the Louisiana Experiment Station in September, 1925. A very ideal distribution of dust was secured; but in spite of this the borers were not controlled. It appeared that the larvae would push the calcium arsenate particles aside before beginning to feed and less than 20% of the larvae were killed by this method of treatment. A very limited test of sodium fluosilicate dusted from the airplane in comparison with the calcium arsenate application gave surprisingly good control of the borer stages. There was some burning of foliage, but this was not severe enough to be considered a serious matter. These initial tests in 1925 furnished the clue which has been followed by far more extensive work in 1926.

At the request of sugarcane growers the Louisiana Legislature in July 1926, appropriated $25,000.00 per annum for two years for sugarcane investigational work. Slightly more than half of this amount has been set aside for entomological studies. This made possible a substantial extension in the program of work which had already been started on the sugarcane borer.

Early in the season it became apparent that the first generation of the sugarcane borer developed more abundantly in early planted corn than in the cane fields. In fact, the first two generations of the borer appear to be concentrated on corn to an important degree and many planters undertook to cut out the infested corn stalks and feed them green to farm animals, or otherwise dispose of them so as to prevent the emergence of the moths therefrom. It was found possible to train an ordinary field hand in a few minutes so that he could remove more than 90% of the borer stages from a corn field and this, as a rule, necessitated the cutting of only between 10 and 20% of the stalks of corn. An examination of corn fields showed that the borer infestation was not distributed at all uniformly through the various fields, but that many fields were practically uninfested and might be allowed to mature their

corn while certain fields had apparently been in a particularly attractive stage just at the time that the moths were flying and had served to attract and to concentrate the egg laying for that generation in that particular locality.

The study of borer control by the destruction of the infested corn stalks was supplemented by insecticidal control tests beginning early in the season and continuing to about the middle of October. The first work was done on corn as borer stages could be found there far more readily than on cane. A Root hand dust gun served for the distribution of the poison. Careful records were kept upon the burning of foliage and upon toxicity to the borer stages. In many of these tests on corn from 55 to 75% of borer larvae of all sizes were killed. The natural mortality among larvae more than half grown on untreated cane averages only 1 or 2% and is, therefore, practically negligible. It was found also that from 5 to 9% of pupae were killed in this treatment of infested corn. Corn foliage is much more susceptible to burning than cane foliage and served therefore as a convenient index in comparing the burning effect of the various samples of sodium fluosilicate and other materials tested.

A casual examination of the normal stalk and top of sugarcane shows that there is only a small area of leaf per stalk that is in a horizontal position or sloping toward the stalk. The structure of the leaf is favorable however to conducting dust, dew or rains down the channel, along the mid-rib of the leaf, to the stalk. This is a very important factor in our consideration of this problem, and explains in a large degree the success that has been obtained in this insecticidal work.

It has been found that with the sugarcane borer the percentage of borer control varies quite directly in proportion to the percentage of water soluble fluorine in the material used. In normal sodium fluosilicate approximately all of the fluorine content (60%) is ultimately water soluble. In calcium fluosilicate the water soluble element is only about 4%. Accordingly, calcium fluosilicate is inactive and does not burn foliage or kill the borers while the sodium fluosilicate is decidedly active and does destroy a large percentage of larvae and may also, under certain conditions, cause some burning of foliage. It is apparent that the principle involved in this use of sodium fluosilicate depends on its water solubility primarily, and this solution washing downward bathes the stalk of the plant and may even extend into the burrows of the borers and cause their death there without having the borer come to the exterior to feed.

There are many problems connected with the insecticidal use of sodium fluosilicate as a dust for cane borer control at least. These problems and possibilities cannot be discussed at this time.

The operation in airplane dusting is essentially similar to that involved in cotton dusting for boll weevil control. The dust hopper of the airplane holds from 500 to 700 pounds of such a material as sodium fluosilicate. The material used in 1926 was shipped in barrels holding 275 pounds net; therefore, two barrels gave conveniently an airplane load of 550 pounds. In part of the tests it was deemed advisable to mix 10% of hydrated lime with the sodium fluosilicate to reduce the danger of burning to the cane foliage. This mixture was accomplished by pouring the required materials together slowly into two barrels and the mixture was made fairly uniform as these were emptied into the hopper of the plane while the action of the agitator in the hopper and of the air blast discharging the dust cloud gave as complete and uniform a mixture of the materials as they reached the cane foliage as could have been secured with more elaborate advance mixing.

In flying over the cane field the pilot would lay down his first swath along the edge of the field away from the direction of the air movement so that he was not obliged to fly back and forth in his own dust cloud. Succeeding swaths were laid down at intervals of about 100 ft. with sodium fluosilicate. This covers about 17 rows of sugarcane on the average. The swath-width with sodium fluosilicate of the lightest density now available is less than half the average width that is usual with calcium arsenate. This means that the airplane must do twice as much flying to cover the same area of cane with fluosilicate as for cotton when using calcium arsenate. The vertical smooth leaves of sugarcane do not hold sufficient poison to show the pilot plainly where his last swath was laid down and ditch lines, roadways, etc., help largely in guiding him to his proper position in the field. It is probable that flag markers set in advance at proper swath widths will be used in future experimental work of this kind. The airplane passes over the cane at a height of usually 10 or 15 ft. above the tops. The distribution of dust from an airplane is so uniform that a heavier poundage per acre is required than was found necessary with hand gun work where the outlet passed relatively much closer to the tops of the plants. Thus approximately 10 pounds per acre on corn had given a very satisfactory degree of control of the borer, but from 15 to 20 pounds per acre were required with the airplane to give about the same percentage of control on cane. The average application given covered approximately 25 acres of cane

with a 500 pound load of poison. This meant that the planes flew approximately 2 miles over cane while discharging this load. The actual dusting time involved was less than 2 minutes per load in the treatment of 25 acres of cane. This is about one-half the acreage-covering rate secured on cotton with calcium arsenate.

In this Louisiana dusting work on cane in 1926 the expense involved has been shared through a cooperative arrangement whereby the planter has borne the expense for the poison used while the Experiment Station has borne part of the application expense and the balance has been carried by the Huff Daland Dusters, Inc., who have been exceedingly helpful in carrying through this initial series of experiments. In this way more than 1300 acres of cane were dusted at the Louisiana Sugar Experiment Station and on the plantations of A. Wilbert Sons & Company at Plaquemine, Louisiana.

The borer infestation of 1926 has been unusually light in cane. Under these conditions the dusting work was begun the last of September and only a single application was made. It is entirely possible that the work of another season with much heavier infestation may be expected to show quite different results. At the present time, however, it appears that the degree of control secured from a single application of sodium fluosilicate as now available has given a very encouraging degree of borer control for initial work. It seems reasonable to expect that a higher degree of control may be possible in the future with improved materials and with a fuller knowledge of the conditions essential to most effective work.

To learn the final results of this work it has been necessary to cut up and examine carefully at the end of the season nearly 3500 entire stalks of cane taken as representative samples from dusted and undusted areas. Examinations made in the field before the dusting had shown the percentage of stalks showing borer burrows of any type. The splitting up of stalks showed the various sizes of larvae killed or still living, and all other stages found were also recorded. The final examinations made about six weeks after the poison application shows the difference in the percentage of joints infested on dusted as compared with undusted areas, after the next generation had time to develop.

Typical records showing these results are given in the following table:

RESULTS OF AIRPLANE DUSTING WITH SODIUM FLUOSILICATE

Variety	Treatment	No. Canes	Infestation % Joints	Infestation % Canes	Borers per 100 canes
Purple..........	Dusted	799	12.63	78.9	45.5
Purple..........	Check	597	23.79	95.1	78.2
Striped.........	Dusted	593	10.2	70.1	36.9
Striped.........	Check	197	27.4	98.0	66.0
D-74...........	Dusted	682	13.2	63.1	38.6
D-74...........	Check	200	28.7	91.5	76.5
D-95....	Dusted	190	13.3	70.0	60.0
D-95...........	Check	200	32.6	98.4	75.0
Totals..........	Dusted	2264	12.08	70.84	41.2
	Check	1194	30.13	95.78	80.1

It will be seen that the average percentage of infested joints in dusted areas is only 2/5ths of that in the undusted areas, and that the number of borer stages found alive per 100 stalks was cut in half by the dust application.

The practicability of applying an insecticidal dust to a crop like sugar-cane has been fully demonstrated at the Louisiana Experiment Station and the planters of Louisiana and of other countries as well may find in this method of treatment a valuable help in controlling various insect enemies of cane and other crops for which no method of treatment has been available heretofore.

MR. R. B. ARNOLD: What was the cost per acre of the dust and its application?

MR. W. E. HINDS: The amount of dust used was fifteen to twenty pounds per acre. We found it was necessary to nearly double the amount we used with hand guns because the airplane distributes evenly over all the spaces and does not concentrate it upon the heart of the plant. The cost for material ranged from eight to ten cents a pound. The cost for experimental work is not, of course, any gauge of what could be done in commercial work. Our actual cost was distributed among the growers who paid for the poison, the experiment station which bore part of the cost of the application, and the Huff-Daland Dusters Inc., who bore the balance of it. We haven't really figured up and wouldn't want to announce any cost per acre. This was strictly experimental work. I think that it would not exceed more than three dollars as an average proposition.

PRESIDENT ARTHUR GIBSON: I would like to ask what he would regard as the best time of the year for applying this.

MR. W. E. HINDS: That would depend absolutely upon the condition of borer infestation. As a rule we would not have conditions calling for it before the middle of August; from then until the end of September would be about the normal season. We expect from what we have done this year that it will take about two applications under heavier infestation conditions.

We have had some burning, but the burning has not been very serious; it has not interfered with the growth of the plant or the value of that cane for planting the following season or the yield so far as yield is concerned.

MR. R. B. ARNOLD: Would it affect the flavor of the juice?

MR. W. E. HINDS: If you were to drink the juice as it comes from the presses, there might be a trace of sodium fluosilicate found in it, but in the process of crystallizing the sugar that is eliminated and you need not fear drinking your coffee or tea with sugar.

MR. R. B. ARNOLD: How about its use for syrup?

MR. W. E. HINDS: The amount present would be so slight it is questionable whether you would more than detect a trace. Only the main stalk goes into the crushing machine.

PRESIDENT ARTHUR GIBSON: The next paper is by W. E. Britton.

ORGANIZATION OF A CO-OPERATIVE CAMPAIGN AGAINST THE ASIATIC BEETLE

By W. E. BRITTON, *State Entomologist, New Haven, Conn.*

ABSTRACT

Injury to lawns in New Haven by the Asiatic Beetle, *Anomala orientalis*, became so prominent late in 1925 that official control seemed warranted. Federal experts advised a co-operative study of the insect and treatment of the soil to kill the grubs. No special funds were available, though State funds could be used and replaced later by a deficiency appropriation. Property owners offered to contribute, and a local civic association appointed a committee to solicit and collect funds. Over $4,500.00 were obtained. The Association also obtained an appropriation of $2.500.00 from the City of New Haven. Congress appropriated $5,000.00 for the work. The area was quarantined. A place was leased for headquarters and an insectary built. Life history studies were made under the supervision of R. B. Friend, and quarantine regulations enforced, and scouting and soil treatment work conducted under J. P. Johnson. Altogether 19 tons of emulsion were purchased and used. Though not all bills have yet been paid, the amount expended for payroll is $7,884.59, and $4,244.21 has been paid for emulsion. A total of $17,089.12 has been expended, apportioned from the four appropriations as follows: Civic Association, $4,086.71; City of New Haven, $2,471.83; Federal appropriation $5,000.00; State funds, $5,530.58.

Late in the season of 1925, the injury caused by the Asiatic beetle, *Anomala orientalis*, to lawns in the western part of New Haven seemed

sufficiently prominent to warrant official action in controlling the pest. Many property owners had asked for information about the insect and for advice about restoring their lawns. Experts from the Japanese Beetle Laboratory of the Bureau of Entomology visited New Haven and, after a brief survey of the situation, recommended that life history studies be made; that the soil be treated with emulsion to kill the grubs; that it should be done co-operatively, and estimated the cost at $25,000.00.

There were no specific funds available for the purpose. To be sure, our State appropriation had not all been expended, and it was not illegal to use it, but the projects and the budget showed that it was all needed for the work already under way.

Some of the property owners expressed a willingness to contribute toward a fund to help, as the work would directly benefit them. A local organization known as the Edgewood Civic Association seemed the logical agency to take the initiative. Consequently, the matter was brought before the Executive Board, and the State Entomologist accepted the invitation to give an illustrated lecture on the subject at the annual meeting of the Association, November 18, 1925. A resolution was passed authorizing the president to appoint a committee to solicit and collect subscriptions. This committee was appointed and outlined its campaign, but before the canvass took place, a public meeting was held in a local junior high school and illustrated addresses were given by the State Entomologist and Mr. Loren B. Smith of the Japanese Beetle Laboratory, Riverton, N. J. A state quarantine was established. The canvass was made in April, and leaflets giving information regarding the insect and the quarantine regulations were distributed to every family in the quarantined area. The money and pledges obtained amounted to over $4,500.00.

As this insect was not known to be present in any other portion of the city of New Haven, and as the treatment would in some measure protect other parts of the city, the Edgewood Civic Association caused a petition to be introduced before the Board of Aldermen asking for an appropriation of $2,500.00. After taking the usual course, including a public hearing duly advertised, the petition passed the Board of Aldermen, and finally the Board of Finance, was signed by the Mayor and the money became available.

Congress was asked to add $15,000.00 to the budget for Japanese Beetle work, the increase to be used against the Asiatic beetle. Congress

responded by appropriating $5,000.00 for the purpose, available July 1, 1926.

We regarded the situation as an emergency, and placed the facts before the members of the State Board of Finance, who approved our plan of going ahead with the work and expending a part of the State appropriation, this amount to be replaced later by a deficiency appropriation.

A stable and yard at 132 West Elm Street were leased as headquarters, and a temporary insectary was built. The life history work was assigned to R. B. Friend, with Paul A. Davis as assistant. J. P. Johnson was engaged to take charge of the quarantine enforcement, scouting and soil treatment work, and he was assisted by Charles E. Brown and about twenty young men, mostly high school boys, as this seemed the best kind of help quickly available.

Bills were paid from each appropriation on duly accredited vouchers. All supervision, permanent apparatus, equipment and supplies, such as hose, nozzles, tools, rental, etc., were paid from the State appropriation. The Federal funds were paid for labor and equipment. Most of the City funds went for labor, and a small portion for emulsion. In general the contributed funds were expended for the purchase of emulsion.

In all, 19 tons of emulsion were used, and bills amounting to $1,500.00 still remain to be paid. The amount paid for emulsion was $4,244.21. The entire payroll amounted to $7,884.59. The total amount expended for Asiatic beetle work was $17,089.12, apportioned from the four appropriations as follows:

Sources of Funds

	Appropriation	Expended
Edgewood Civic Association	(Indefinite)	$4,086.71
City of New Haven	$2500	2,471.83
Federal Bureau of Entomology	5000	5,000.00
State of Connecticut	(Indefinite)	5,530.58
Total		$17,089.12

President Arthur Gibson: Mr. R. B. Friend will now present his paper.

THE ASIATIC BEETLE (*ANOMALA ORIENTALIS* WATERHOUSE)

By R. B. Friend

Abstract

The Asiatic beetle (*Anomala orientalis* Waterhouse) in Connecticut has usually one generation a year, but in a small percentage of cases it takes two years to complete the life cycle. Hibernation takes place as a rule during the third instar. The larvae pupate during June and July, and adults occur during July and August. If the larvae hibernate during the first instar, they do not complete development the following season but go thru as larvae and pupate a year later. This insect seriously injures lawns by eating the grass roots during the larval stages. The injury is particularly noticeable during September. The adults are not pests of any importance.

The Asiatic beetle is an insect rather recently imported into the United States, and it may become a serious pest if it continues to spread and multiply. The life history notes here given are the results of observations in Connecticut during 1926.

The adult beetles are of the typical Scarabeid shape and 8–12 mm. in length. The color varies from entirely straw-colored to entirely black, but typically the beetle is straw-colored with black markings. The thorax may be entirely black except for a straw-colored margin, or there may be a light line medially which divides the thorax into two black areas. The elytra are usually straw-colored with one or two black U-shaped bands and a dark spot at the inner basal angle of each elytron. The ventral side of the insect is light or dark, corresponding to the predominating color of the dorsum. The females are usually larger and lighter colored than the males, but black females occur. The sexes may be determined by the relative length of the tibial spur on the prothoracic legs, this being longer and narrower in the female.

The egg is small, white, and ovoid when first laid. After being in the soil a short time, it swells to a spherical shape and a diameter of about 1 mm. The fully grown larva is a little over 2 cm. in length and may be distinguished from other Scarabeid larvae by the number and arrangement of the two median rows of short pointed spines on the ventrum of the anal segment. There are 12–14 spines in each row, and the rows diverge slightly craniad. The arrangement of the more lateral, larger hooked spines is also characteristic.

This is a grassland insect, spending its larval life in turf, mainly in lawns, where it occurs in numbers up to 1000 per square yard in spots. The infestations are not uniform over any large area and usually not over any one entire lawn. The larvae feed on grass roots and dead organic matter close to the surface of the soil, and in September the

grass is frequently killed. The adult is not injurious to anything except flowers in Connecticut.

The great majority of larvae winter in the last instar at a depth of from ten to fifteen inches in the soil. They come to the surface to feed the last of April and first of May, and continue feeding for about six weeks. The injury to grass is not superficially apparent at this time. If a dry spell of weather occurs, the larvae will go more deeply into the soil. About the middle of June they go into the prepupal stage at a depth of three to nine inches below the surface. A large subdermal deposition of fat gives the prepupa a yellowish-white appearance, and the legs are folded and useless. After seven days they pupate, and this stage lasts fifteen days. We have found pupae from June 17th to August 19th in New Haven, but the maximum number were found the last week in June and the first week in July. The first adult was found in the field June 25th, and the last August 28th, the maximum number being picked up the first three weeks in July.

The adults remain in the ground a varying length of time after emergence from the pupal stage, but we have records of oviposition one day after emergence. A considerable part of the adult life is spent in the ground. Most of the flying takes place between 7:30 and 10:00 a. m., and between 1:30 and 4:30 p. m., according to the records of the scouting crew, but there is some evidence of night flying and attraction to lights at night. The flight is rather swift and of short duration, usually but a few feet, although occasionally a long flight is observed. As an indication of the extent of movement above ground, it is illuminating to note that twelve scouts picked up only 2402 beetles in two months, and there were a large number of infested lawns any one of which contained several times that number of larvae. The adults feed on flowers, eating the petals and the center of the blossom, and in the insectary we feed them pieces of ripe apple. There is a decided preference for light-colored flowers, and roses, hollyhocks, phlox, and dahlias are preferred in the order given. In no case is the feeding very extensive, and it may be moisture that is sought, for the beetles burrow into a wet sponge more eagerly than into a piece of apple.

The eggs are laid singly in the ground at a depth of from three to nine inches. Oviposition occurs during both night and day, and a female will lay a few eggs at frequent intervals for several days. The largest number of eggs we secured from one female was thirty-two, laid over a period of seven days. Another female laid seventeen eggs over a period of twelve days. Eggs were found in the field from July 19th to September 10th.

The period of incubation averages twenty-eight days, but this varied from ten to forty-one days in the insectary. Moisture is necessary for development of the egg, and exposure to air-dry soil for ten days is usually fatal. Under natural conditions in New Haven the soil does not get as dry as this.

Upon hatching, the young larvae make their way up to a position close to the surface of the soil and there feed on roots and organic matter. We found the first larvae in the field August 12th. Feeding continues until freezing weather, when the nearly full-grown larvae go down more deeply to hibernate. During the feeding period they molt at least twice in the majority of cases, but some individuals hibernate before the first molt. This last season the downward migration began about October 10th, and diggings made the first ten days in November indicated most of the larvae were at a depth of six inches or more at this time. Injury to the grass is not apparent until September, probably not until the second instar is well under way. Where the infestation is heavy, the dead turf is easily rolled back, disclosing the larvae in the upper inch.

There is usually one generation a year, but larvae which hibernate in the first instar go through the following season as larvae, hibernating the second winter in the third instar. These individuals take two seasons to complete the life cycle.

The most important natural enemies we have observed are birds and ants, and many larvae are destroyed by both these agents. We hope to establish parasites in the future.

This beetle is reported as common on all the islands of Japan, and it throve in Hawaii until controlled by an introduced parasite. This latitude range extends about as far north as northern United States and much further south than Florida and Texas. In New Haven we have one generation a year with the possibility of a two-year cycle in a few cases. In Hawaii there are two generations a year. To date, all our infestations have been on grassland, and the only important crop injury of which there is record is to sugar cane in Hawaii. The injury which this insect may do is problematical.

MR. W. A. HOOKER: I would like to ask Dr. Britton in regard to the extent of the infestation by this pest. It is my understanding that the infestations in New York state are separate introductions.

MR. W. E. BRITTON: It has been discovered on Long Island, also in Westchester County, New York. We don't know, of course, how it got

there, but there are a large number of nurseries there, and also private individuals might have imported it before nursery stock was kept out by the Federal quarantine. It may have been introduced into those places at the same time, or even before, it was introduced into Connecticut, as far as we know. It must have been in this one place on Long Island as long as it has been anywhere in Connecticut.

PRESIDENT ARTHUR GIBSON: The next is a paper by J. L. King, H. W. Allen and H. C. Hallock.

Mr. Allen read the paper.

THE PRESENT STATUS OF THE WORK ON THE PARASITES OF *POPILLIA JAPONICA* NEWMAN.[1]

By J. L. KING, H. W. ALLEN and H. C. HALLOCK, *U. S. Dept. of Agriculture, Bureau of Entomology*[2]

ABSTRACT

This paper is a summary of the parasite introduction work since January 1, 1925, at the Japanese Beetle Laboratory, Riverton, N. J.

"The important points discussed are the spread of the parasite *Centeter cinerea* Ald., in New Jersey and Pennsylvania. The successful establishment of *Tiphia popilliavora* Roh. from a very small liberation is noted. The work on *Prosena siberita* Fab., *Dexia ventralis* Ald., and *Tiphia vernalis* Roh., and several other parasites is also discussed. There are some concluding remarks on some of the problems connected with parasite introduction work.

This paper deals with the progress of the parasite work at the Japanese Beetle Laboratory from the fall of 1924 to the fall of 1926 and is the third of a series published in this Journal[3]

The establishment of a natural balance, which is the fundamental idea

[1]Contribution No. 19, U. S. Department of Agriculture, Japanese Beetle Laboratory, Riverton, New Jersey.

[2]In presenting a paper of this nature which is necessarily based on the efforts of several workers, it is with sincere appreciation of their work that the following acknowledgments are made. Messrs. J. B. Cronin and L. B. Parker were formerly connected with the receiving station and contributed, with the joint authors, to the results presented in this paper. The writers also wish to acknowledge the careful work of the men in the foreign field and its vital importance in contributing to success at the point of colonization. Special acknowledgment for the collection of foreign parasite material is due Mr. Curtis P. Clausen, in charge of the foreign phase of this project. Mr. Clausen, who is located in India, is responsible for all the Indian material, and his assistants Mr. H. A. Jaynes for all material from China and Mr. T. R. Gardner for material from Japan and Korea.

[3]Other papers are: (1) A preliminary report on the foreign parasites of Popillia japonica. Clausen, Curtis P., and King, J.L., JOUR. ECON. ENT., Vol. 17, pp. 76–79, 1924. (2) A report on certain parasites of *Popillia japonica* Newm. King, J. L., and Hallock, Harold C., JOUR. ECON. ENT., Vol. 18, pp. 351–356, 1925.

behind any biological control, is at best a slow and tedious process. The difficulties encountered are numerous and we believe that in the case of soil-inhabiting insects, as Popillia and certain of its parasites, these difficulties are somewhat above the average. However, in spite of this, the recovery of two species of Tiphia during the past season has shown that the difficulties may yet be overcome. Studies of the habits and improvement of insectary methods as used with the more difficult species have yielded results encouraging enough to lead us to believe that in the future even these species may be added to our fauna.

Discussion of the Tachinid Parasites

Centeter cinerea Ald. Although this Tachinid was established in 1923, a further shipment of approximately 50,000 host beetles was received at Riverton in the fall of 1924. Approximately forty per cent of this lot contained Centeter puparia. This consignment was divided into two equal lots. One of these lots was wintered under the soil out-doors and the other was wintered in a cool cellar. Out-door hibernation proved the better since it gave 71 per cent of the total emergence. The 1925 liberation was made in the 1924 colony center at Torresdale, Pa., and consisted of 2,180 unmated adults.

This species is now firmly established in the Japanese beetle area. The known area of distribution has increased to 60 square miles and now extends into Pennsylvania.

Ochromeigenia ormioides Town. Additional shipments of this nocturnal Tachinid were received from Japan during the summers of 1925 and 1926. The methods of shipment and insectary manipulation described in an earlier paper were found satisfactory and are still used. Unmated adults, including 228 in 1925 and 743 in 1926, were released at the 1924 colonization point near Riverton, N. J., in order to strengthen any possible colony which may have started there from previous liberations.

In recovery experiments no Ochromeigenia were obtained from approximately 23,000 beetles, collected at the colonization point, during the summer of 1926. Although the failure to recover up to the present time has been disappointing, further attempts to colonize will be made.

Prosena siberita Fab. Additional shipments of *Prosena siberita* were made during 1925 and 1926. The 1925 shipment consisted of 25,000 Japanese beetle grubs from which 1,693 adults were obtained. The same number of grubs was received in 1926 and yielded 1,287 parasites. The method of shipment, which was the same as that used in 1924, has given, on the whole, very satisfactory results. The methods of in-

sectary manipulation of this parasite have also been practically the same as for 1924.

The 1925 shipment was colonized at Holmesburg, Pa., and the 1926 shipment was released at the center of the original colony at Moorestown, N. J. Each location was selected because it combined a number of conditions supposedly favorable to the fly, such as an abundance of late maturing grubs of the host and the proximity of mesophytic woodland fringe with an abundance of flowers and luxuriant vegetation frequented by large numbers of native Tachinidae and therefore probably a favorable habitat for the introduced species. The Moorestown colony has now received liberations during 3 seasons. Repeated liberations have been made at this colony center, since there has been no reason to question its suitability to the parasite and since it has been thought that new liberations would serve to strengthen a young struggling colony and increase its chances for establishment. To date 7,560 parasites have been liberated, of which slightly more than 1,600 were released in the Pennsylvania colony and the remainder in New Jersey.

It is as yet somewhat too early to state definitely whether the species is established. Although there have been some favorable indications, the attempt to colonize this species has proved rather disappointing to date, and the parasite, if present, occurs in such small numbers that it has been impossible to measure its presence quantitatively by any of our recovery work. In 1925 one unfertilized female was taken 5 miles from the point of liberation and in 1926 a single fertile female was recovered a few hundred feet from the colony center. Both recoveries have been regarded as individuals from the liberations of the current year, but it is possible that they were from an established colony.

This fly is a polyphagous species naturally parasitic on the Japanese beetle and widely distributed in eastern Asia. There appears to be no reason why it should not become established in eastern North America. However, several years' work with the species has emphasized the importance of several of its characteristics which increase the difficulty of successful colonization. One of these is what might be termed the pronounced dispersive tendency in a colony liberated in the field. The adults are strong fliers and disappear from view into space or the high trees over-head, almost instantaneously at the time of liberation.

It was found during the summer of 1926 that adults which do not mate freely in confinement would do so quite readily in large out-door cages, covered with black mosquito netting. By releasing mated

females we now hope to counteract to some degree any disadvantage arising from the dispersive tendency described above.

Dexia ventralis Ald. The first consignment of this Korean Dexiid was received at the laboratory in July, 1925. This shipment consisted of 850 Popillia grubs which had been inoculated with first-stage Dexia larvae. During the season 28 adults emerged from this lot and gravid females were obtained. Maggots obtained from these females were allowed to parasitize Popillia grubs but failed to mature.

The first 1926 shipment consisted of 4,116 host grubs containing second generation Dexia maggots and was received at Riverton in July. Upon arrival most of the parasites had left the host and were in the puparial or larval stage. These were placed in soil for emergence. The total emergence was 1,501, of which 1,352 were released near Haddonfield, N. J. Mating was obtained in captivity and gravid females also were found at the point of liberation. *Popillia japonica* grubs were inoculated with first-stage Dexia larvae, which were obtained from the gravid females, and adults emerged from these in September.

During the early fall of 1926 three consignments of the third-generation Dexia parasites contained in 5,684 host grubs were received at the laboratory. From these consignments 176 adults emerged and were liberated near Haddonfield. The adults of *Dexia ventralis* do not spread rapidly from the liberation point as is the case with Prosena. At the Haddonfield colony for several days following liberation, especially during the evenings, many adults were observed resting upon the grass, or darting about, flying but a short distance before alighting again.

Discussion of the Scoliid Parasites

Tiphia popilliavora Roh. During the past two years only shipments of adults have been made. In 1925, from a shipment of 1,030 females arriving from Koiwai, Japan, 43 active females were obtained at Riverton and liberated at once. In 1926, from 1,219 females shipped from the same locality, 22 active females were obtained. The 22 adults of the 1926 shipment were used in propagation work from which ovipositions on 331 Japanese beetle grubs were obtained. The cocoons from this lot have been placed in storage.

Four separate colonizations of this species have been made within four miles of the laboratory at Riverton. This parasite was recovered for the first time during the past season and appears to be definitely established, though as yet present in rather limited numbers over a small area. Numerous males were encountered near the Riverton

laboratory on the flowers of wild carrot in August, and later, parasitized Japanese beetle grubs were recovered at the same locality in considerable numbers over an area about 300 yards in diameter. The present colony, which must number at least some thousands of individuals, has very likely sprung from a very few females released in 1922.

Tiphia vernalis Roh. The first shipment of this Korean *Tiphia* reached Riverton late in August, 1924. From this lot 116 adults, of which only 30 were females, emerged, and 30 adults, of which 17 were females, were released near Moorestown, N. J., in early May, 1925. A second consignment of 5,965 cocoons reached the laboratory during the fall of 1925. The emergence from these during the spring of 1926 was 275 adults. The reared females were mated and oviposited readily upon *Popillia japonica* grubs in confinement.

Shipments of adult *Tiphia vernalis*, first made during the spring of 1926, have proved more promising than shipments of cocoons. Two lots, containing 2,790 field-collected females, were shipped from Korea. When they reached Riverton 411 female Tiphia were still living. The females were used in propagation work from which 4,301 parasitized grubs were obtained. The parasitized grubs were liberated at the 1925 *Tiphia vernalis* colonization point. Each grub bearing a Tiphia egg was placed just under the sod. The liberated material was scattered over several acres. In October, 1926, this plot was examined. Several cocoons were found about 3 inches below the surface, all of which contained larvae that were in excellent condition. It is hoped that these cocoons formed under normal conditions will give rise to a colony which will be sufficiently strong to insure the establishment of the species.

During the season of 1926 *Tiphia vernalis* was also tried on *Anomala orientalis* grubs in confinement. This Tiphia accepted the Anomala grubs readily and cocoons were obtained from the ovipositions upon the host.

Tiphia No. 1851. This species[4] which occurs in considerable numbers in sandy country and under subtropical conditions at Miho, Japan, was first received at Riverton in November, 1925. This first shipment consisted of 1,030 insectary reared cocoons which arrived from Japan in excellent condition. During the present season an adult shipment has been tried, 1,000 females being sent over in early October. In this lot 111 arrived alive.

[4]Among the species of Tiphia being imported are certain undescribed or undetermined species which have been given insectary numbers, to which reference will be made at the time of publication of their authoritative names and descriptions.

Two methods of hibernation were tested with the 1925 shipment of cocoons. The first lot was layered between sphagnum and buried in soil outdoors, and the second allowed to remain in the original containers in a cool cellar. The better results were obtained in the lot wintered over in the cool cellar, repacked in the early spring and kept under rather dry conditions until emergence. From the 1925 shipment, 325 adults emerged during July, 1926, and from this lot 90 mated females were obtained, which oviposited readily upon Japanese beetle grubs in confinement. The first liberation of 72 mated females was made in mid-July, a time when the greater part of the Japanese beetle infestation had passed over into the unsuitable pupal and adult stage. A location was found at Merchantville, N. J., however, in which third-instar grubs were still abundant, and other conditions apparently quite favorable for the colonization of adult Tiphia.

Examination of Japanese beetle grubs from the liberation area was made daily from July 19 to 30. Altogether 605 grubs were examined and seven were taken bearing the eggs of this species. The discovery of the fact that this species will attack Japanese beetle grubs in the field is highly encouraging, for although it has been reared in large numbers in the insectary upon this host, it is known in Japan only as a parasite of a species of *Anomala* and does not occur abundantly there in Popillia infested territory.

This parasite has a second generation at Miho, Japan, with adults appearing in September, but our insectary reared material at Riverton during the season of 1926 has passed through but one generation, and no evidence of a second generation has been discovered at the colonization point. This is not an unexpected development, since the laboratory is located at a considerably colder latitude than the native home of this species in Japan.

The adult shipment of 1926 arrived in late October, at the close of the season at Riverton and too late to risk liberation of adults, particularly of a subtropical species. Consequently these females were employed in propagation work, by which a total of 448 parasitized grubs were obtained. The cocoons from these will be wintered over and used during the coming season.

Tiphia No. 2049. Very large shipments of a fall-emerging species of Tiphia, parasitic on species of Popillia and shipped from Shillong, Assam, India, have been received since the early winter of 1925. All have consisted of field-collected cocoons, shipped in small packages by parcel post. Altogether 19,560 cocoons have been received at Riverton.

Unfortunately, owing to the long time spent enroute, a period which averages about 60 days, and probably also the passage through areas of widely varying climate, the vitality of the parasites is much reduced by the time they have reached their destination. Adults failed to emerge at Riverton this fall and the species has passed into its second winter in the cocoon stage. Owing to the presence of a small number of Rhipiphorid secondary parasites and a small number of Chalcids, these cocoons have been handled with great care, being kept in tight containers within a specially constructed cage.

Tiphia No. 114. Adults of this species were first shipped from China in 1926. From 5 consignments, 118 living females were received at the Riverton laboratory during May, 1926. These Tiphia were handled in the same manner as *Tiphia vernalis*, and a small colony of 89 parasitized grubs was placed at the same locality as *Tiphia vernalis*, near Moorestown, N. J.

Tiphia No. 2036. Another Indian species of Tiphia emerging in the spring and parasitic upon species of Popillia was first received at Riverton in the fall of 1925. No adults have as yet emerged at this station. Approximately 2,300 cocoons, most of which were reared in India, and the remainder field-collected, are in winter storage at Riverton.

Campsomeris annulata Fab. Work was continued on this Scoliid parasite during 1925 and 1926. Sixteen consignments of adult females of *Campsomeris annulata* were received at Riverton during 1925, and 2,162 field-collected females were liberated near Moorestown, N. J. During the same period 95 reared adults which had emerged from the 1,198 cocoons received during the 1925 season were liberated at the same locality. Eleven shipments of adults were received in 1926 and 1,945 field collected females of Campsomeris were liberated at the same locality. Additional Campsomeris from the 1926 shipments, to the number of 336, were used in laboratory experiments, by which it was found that Campsomeris would occasionally oviposit on *Popillia japonica* grubs, but not readily.

Some Problems Connected With Parasite Introduction

The problem of perfecting methods of shipment is naturally in the hands of the men stationed in the Orient. The dipterous parasites are being successfully imported as puparia, in the case of those with a long pupal period, and as larvae within the host for species with a short pupal period. The various species of Tiphia are being shipped with a rather variable degree of success in the cocoon and adult stages. The time consumed by shipments enroute is a very important factor affect-

ing successful introduction. Even when the actual mortality is relatively low, our observations indicate that a long period passed in travel is very unfavorable to the parasite and greatly reduces its vitality. Shipments from Japan come through in about 18 days, those from China in about 22 days, while shipments from India have averaged approximately 60 days.

Flies have been liberated, principally in the adult stage, unmated. This method proved entirely satisfactory with Centeter but not entirely so with Prosena. However, it was discovered this season that Prosena will mate readily in large cages covered with black mosquito netting, so that, in the future, liberations of mated females will be made. The Tiphia species have been released largely in the egg stage on the host or as mated adults. The danger of importation of secondary parasites, while not so great as with the parasites of insects which spend a greater part or all of their life about the soil, does exist. Rhipiphorids and Chalcids occur in the cocoons of field-collected Indian Tiphia, and other secondary parasites in the puparia of *Centeter cinerea*. Fortunately, however, the problem of secondary parasitism has been minimized by the extensive insectary rearing of parasites abroad.

It is our conclusion that colonies of powerful flying species, such as Prosena, should be very large, while it would appear that success may come from the liberation of much smaller numbers of Tiphia, the females of which spend much of their life crawling and digging over a rather limited area of ground.

In our insectary work, the matter of hiberantion is one of considerable importance. Nearly all species of Tiphia handled at our insectary winter over rather poorly. On the whole, greater success has been obtained with cocoons kept in a cellar than with those buried out-doors under the soil, although the results vary with the species. It has been noticed that great mortality results from repacking Tiphia cocoons in soil when once removed from the original cell. For this reason, as well as through risk of introducing secondary parasites, it is not feasible to liberate in the cocoon stage. Consequently large numbers of cocoons must be held for varying periods up to a year or more for adult emergence. A number of different setups for holding inactive stages of Tiphia until emergence are being tried, all of which are designed to furnish the requisite degree of moisture, isolation for each cocoon, and something approaching the low variation in temperatures which normally occurs in the soil. Nearly perfect emergence can be obtained with Prosena by simply seeding puparia on moist soil and covering with a

layer of damp sphagnum moss while Ochromeigenia seems to do much better when allowed to force its way up through several inches of soil.

Another puzzling problem is the possible hybridization of nearly related varieties or species introduced into the Japanese beetle area from different localities, and the probable effect of hybridization on the ultimate success of the parasite. *Tiphia popilliavora*, a natural parasite of the Japanese beetle, has now been successfully colonized. A very closely related species or variety has been found in Korea and another in China, which are naturally parasitic on indigenous species of Popillia, but not on *P. japonica* which does not occur on the mainland. The Chinese form is apparently a more abundant parasite in its area of distribution than is *T. popilliavora* in Japan, it is more hardy, and in other ways appears a very valuable species. The question arises, will its introduction result in fusion with the Japanese race, and if so will this be beneficial or not?

The work up to date with the parasites of the Japanese beetle has indicated that each species, even among closely related forms, possesses characteristics to which the method of procedure must be carefully adapted in order to increase the probability of successful establishment.

Adjournment: 5 p. m.

Saturday Morning Session, January 1, 1927, 9:45

President Arthur Gibson, in opening the meeting, expressed hopes that 1927 would be one of great success to every member of the Association.

PRESIDENT ARTHUR GIBSON: The first paper this morning is by J. Peter Johnson.

SOIL TREATMENT AND SCOUTING FOR THE CONTROL OF THE ASIATIC BEETLE

By J. PETER JOHNSON, *Connecticut Agricultural Experiment Station*

ABSTRACT

Approximately 1400 acres are now under quarantine for the Asiatic beetle, *Anomala orientalis* Waterhouse, in New Haven, Conn. Altogether 2402 beetles were found during the summer scouting season, and 4576 diggings were made in the spring and fall.

The heavy infestation is concentrated in 300 acres, and the larvae injure the lawns severely. Carbon disulphide emulsion was used successfully in controlling them, and during the past year 100 acres were treated.

On April 15, 1926, a quarantine was established in Westville, New Haven, Conn., for preventing the spread of the Asiatic beetle, *Anomala*

orientalis Waterhouse. At the same time preparations were begun for the treatment of the soil to kill the grubs in order to control, and, if possible, eradicate this pest.

The Quarantine

The quarantine included an area of approximately 400 acres and prohibited the shipment of soil, loam, plants with or without soil about the roots, turf or sod trimmings, lawn clippings, ground litter, weeds and manure or compost which had lain upon the ground, excepting where certification after treatment or inspection was possible.

After the summer scouting was over, the quarantine was revised, effective November 10, 1926, and nearly 1000 acres of new territory were included. There are now approximately 1400 acres under quarantine. At the present time there is no need for a farm products' quarantine.

Diggings

In the spring it was thought necessary to make diggings throughout the quarantine area to determine the nature and extent of the infestation. Altogether 1800 diggings were made, approximately 50 feet apart. The infestation was found to be spotted, and in places there were as many as 1000 grubs in a square yard.

Diggings were resumed in the fall, as the summer scouting work did not give all the information needed for intensive control work. The spring work was duplicated in addition to all areas in which adult beetles were found, and 2776 diggings were made.

During the season 50 or more complaints of possible grub infestations were received from outside of the area. These were examined, and on May 17, 1926, an infestation was found at 437 Savin Avenue, West Haven, and on October 4, 1926, another infestation, one city block in extent, was found on Washington Manor Avenue, West Haven.

Scouting

During the second week in June, information obtained by field diggings indicated that the grubs were approaching the pre-pupal stage. The first pupa in the field was found on June 17, and scouting was begun at this time. The first beetle was found on June 25.

Altogether, 2402 beetles were found during the season; 1132 were recorded on 25 different varieties of plants; 604 on grass, on the ground and in the ground; 147 on the wing, while the others were recorded only as to their location. Beetles were found more prevalent on roses, grass, hollyhocks, phlox, dahlias, beans and corn, named in respect to the number of beetles found on each.

The adult beetle is more readily seen when resting than when flying. It is a rapid flyer and may skim along a few feet above the ground or high in the air.

Beetles were found at night, resting on telegraph poles, on the ground, and as many as eighteen were caught in a half hour flying against the glass and on the sill of a brightly illuminated store window.

The territory surrounding the known infested area was thoroughly scouted, and beetles were found north, south, and east of the quarantine area. The last beetle in the field was found on August 28.

Soil Treatment

The soil treatment was made with emulsified carbon disulphide diluted in water. All of the emulsion was made by a commercial firm in Philadelphia, Pa., according to the formula recommended by the Japanese Beetle Laboratory. It was used at the rate of one quart of emulsion to fifty gallons of water, and three pints of the liquid were applied to one surface square foot. This dose is effective to a depth of nearly three inches, obtaining a grub kill of 98% when applied properly.

In all, 366 properties, totaling 43.5 acres, were treated.[1] Altogether 38,000 pounds of emulsion were used and over 800,000 gallons of water were employed in diluting it. During the spring, seven "Thomas proportioning machines" with a capacity of 600 gallons an hour, and in the fall, four similar machines and another of 1200 gallons, capacity were used in diluting the emulsion.

House hydrants, and, to some extent, fire hydrants, furnished the water supply for the spring treatments. However, much difficulty was encountered with varying water pressure decreasing the efficiency of the work. Therefore, during the summer, fire hose, using fire hydrants as a source of supply, was tested and adopted for fall treatment. This method enabled the machines to work constantly at a maximum flow.

As a whole, the soil treatment has been very effective in reducing the number of grubs throughout the area. The grub injury now apparent in Westville is located on those streets which were not treated, or injured prior to treatment.

A summary of the work done is given in the following table:

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[1]The acreage is the actual surface treated, but the total area including houses, garages, and sidewalks, would be nearer 100 acres.

	Treated		Emulsion used		Water used	No. diggings made
	No. premises	Acres	Lbs.	Tons	gallons	
Spring	147	21	18,500	9¼	400,000	1800
Fall	219	22.5	19,500	9¾	404,377	2776
Total	366	43.5	38,000	19	804,377	4576

PRESIDENT ARTHUR GIBSON: The next paper is by E. Avery Richmond.

A NEW PHOTOTROPIC APPARATUS[1]

By E. AVERY RICHMOND, *Agent, United States Department of Agriculture*

ABSTRACT

An apparatus recently devised for use in connection with certain phototropic experiments on the Japanese beetle, *Popillia japonica* Newm., relative to the value of color and light.

I. INTRODUCTION

Since the appearance of *Popillia japonica* Newm. on American soil the rôle played by light in the life activities of the adult beetle has been only briefly considered by investigators. Apparently the first attempt at investigating this question was stimulated by Uchida's translation of a Japanese text-book by Matsumura, as cited in 1917 by Dickerson and Weiss. According to Matsumura the beetle could be attracted by lights.

Goodwin, 1919, made an effort to put into practice the thought expressed in this translation but, as is doubtlessly well known, his experiments were strikingly negative. In fact, in certain cases, more beetles came to unlighted lanterns. The fact that beetles become inactive after dark, especially when the nights are cool and damp, tends to discount any noticeable response of this sort.

The next investigation resulted in the interpretation of the Weber-Fechner law in relation to the adult by Moore and Cole, 1921. The main thoughts expressed by these authors are taken verbatim from their summary as follows:

1. "Light and a temperature above 23 degrees C. are necessary for the activity of Popillia." 2. "The effect of light, as indicated by the rate of locomotor response, is related to light intensity according to Fechner's expression of Weber's law." It was also stated in their paper that "under ruby light and in the dark, most of the beetles become quiet and show no response to gravity. Occasional individuals, which do not move, show a retarded response. All are roused to activity by

[1]Contribution No. 22, United States Department of Agriculture, Japanese Beetle Laboratory, Riverton, New Jersey.

illumination from any direction while a great increase in the strength of the light causes marked acceleration of movement and flying."

During 1923, F. J. Brinley conducted several experiments in an endeavor to test the effect of colored spray deposits. Precipitated chalk (CaCO3) was impregnated with white, black, red, orange, yellow or blue dyes. The conclusions showed that the beetles did not feed on foliage which had been sprayed with any of the colored chalks, as much as they did on the checks or unsprayed leaves. However, there was no color upon which they did not feed.

These observations were somewhat corroborated by the author's experience with "color-squares." In 1924 differently colored cloths, one foot square, were hung on adjacent trees of an orchard and the beetles, clinging to them, were counted at regular intervals The cloths alone were not attractive to any extent, so they were dipped in a 10% geraniol emulsion. This attracted the beetles in large numbers but no striking preference for any particular color was observed In fact, it appeared that, on some days, the white cloth led in numbers attracted. This seemed to contradict some beliefs that white repels, but such attraction may be entirely due to the geraniol present.

McIndoo, 1926, described an insect olfactometer, the principle of which depends upon attraction by light In 1924 he used this instrument successfully in experimentation with the Japanese beetle. The source of light employed was either the sun's rays or a "daylite" bulb (Edison Mazda, 110 volts and 75 watts) The beetles readily moved from the dark bottle, used in this apparatus, to the y-shaped glass portion connected with it

II. Discussion of Some Factors Concerned

The expressions of the above authors tend to indicate clearly the value of light in relation to the activities of the beetle. All responses of the adult to light rays show that it is strongly photopositive. However, as Moore and Cole, 1921, have written, negative geotropism and photokinesis must also be taken into consideration.

Evidences of positive phototropism are common in the field and it seems impossible to bring forth strong enough proof to discount any of these observations. On the other hand, when an apparently photonegative response is observed, there seem to be ample reasons for eliminating such a record. For example, the return of the female to the soil for oviposition, although it appears a clear case of negative phototropism or positive geotropism, can be explained as a result of some

potent internal stimulus rather than the direct influence of light or gravity.

Among the activities in nature, which substantiate opinions concerning the desire of the beetle for light, are included emergence from the ground; a primary attack of plants in the open, the tops of trees or the periphery of woodlands; the selection of the upper surfaces of the leaves for feeding with perhaps the exception of peach leaves; the preference for the sunny portions of food plants; and the general inactivity observed on cloudy days even if the temperature and humidity are apparently entirely satisfactory.

Early insecticide results demonstrated clearly the often repeated fact that arsenical sprays usually repel the beetle. Just what the deterrent factors are has always been a much disputed question. Data given in the Sixth Annual Report of the New Jersey State Department of Agriculture, 1921, seemed to indicate very definitely that the beetles object to eating spray deposits consisting of small powdered grains of any nature whether poison or not. Moreover it was stated that the color of the sprays seemed to make little or no difference in this respect.

In 1922, Moore reported that Japanese beetles were not repelled from sprayed foliage by the color, taste, or physical condition of the arsenicals but appeared to be influenced by certain toxic effects resulting from eating some of the poison. Smith, 1923, mentioned these points in his review of the feeding habits of the adult. Kelley and Moore, 1923, in writing on sprays for control expressed the view that the beetle leaves the sprayed foliage on account of toxic effects before obtaining a killing dose. In order to overcome such a difficulty they recommended more thorough spraying and an increase in the strength of the arsenical used.

Van Leeuwen, 1926, stated that the effect on the insect of the color, odor, taste or physical appearance of the deposit was not yet established. The efficacy of the coated arsenate of lead apparently strengthened the toxic hypothesis advanced by Moore in 1922 but there are surely other factors which can not be ignored in this connection.

Such confusion of thoughts led me to consider, in 1924, the relative value of color upon the Japanese beetle and the first attempt was the crude test just mentioned, with the color-squares. Following these investigations, plans for the erection of the phototropic apparatus, described in this paper, were outlined. In using this apparatus it must be remembered that, although its operation is relatively very simple, many factors have to be taken into consideration before drawing too hasty conclusions.

III. Acknowledgments

Considerable credit for the general scheme of this outfit is due Loren B. Smith, who, together with the author, drew up the plans. During the summers of 1925 and 1926, Mathew Jameson and Ezekiel Rivnay, both of the Massachusetts Agricultural College, ably assisted in the conduction of experiments pertaining to these problems.

IV. Description of the Apparatus

(Figures 14, 15 and Plate 12)

The apparatus consists of a wooden cabinet, octagonal in shape, elevated about two and one-half feet from the ground by eight outer and

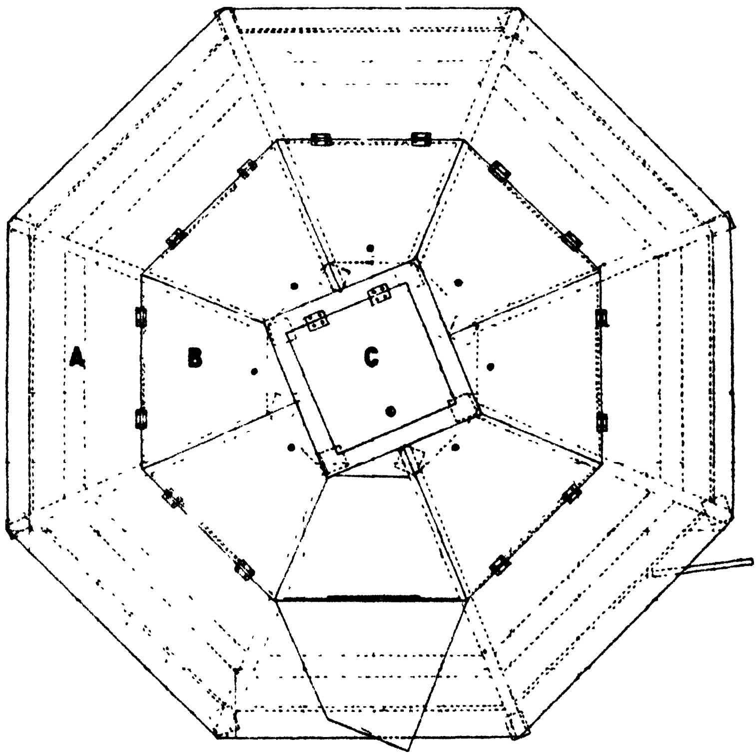


Figure 14.—Drawing of phototropic apparatus from above (Each large square represents one square foot).

four inner erect joists and placed beneath a shed in order to protect it from the weather. It is thirty-six feet around, the greatest width is

[3]Since this outfit is home-made the inside measurements should be considered as being only approximate.

eleven feet and it is about two feet deep.[2] The material of this structure consists of matched boards, wall board, quarter round stripping, etc. It is coated with a flat white paint inside and out.

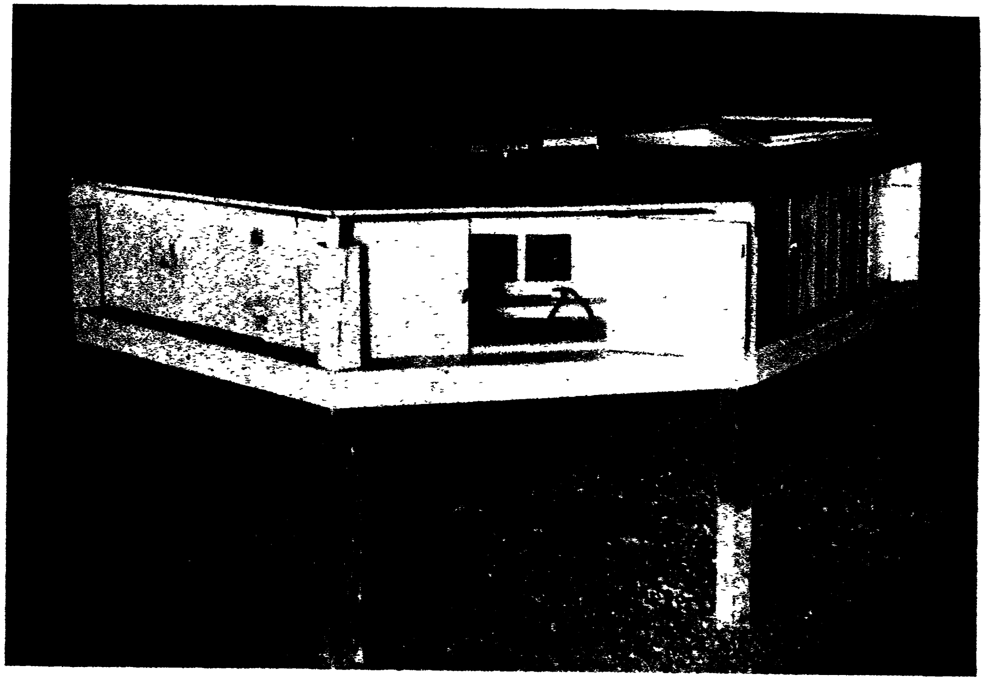
In addition to a central chamber (C) there are eight distinct outer compartments, as the form of the apparatus suggests. Each compartment is composed of an outer or lighting chamber (A) and an inner or color chamber (B). Between these two chambers are two apertures for the reception of glass color filters, six and a half inches square. These are held in position by wooden strips, placed on both sides of the partition and fastened with bolts. The filters can thus be readily removed or interchanged.

Chamber A is sixteen and a half inches long and eighteen inches high. It is thirty-four inches wide at the partition, separating this chamber from chamber B, and forty-eight inches wide at the outer wall. The chamber is well aerated from beneath by holes and by a space between the outer wall and the top so as to prevent the temperature from becoming too high. Wall boards properly placed prevent the entry of any direct light rays from the outside Entrance to this chamber is attained by a door made in the outer wall

Each lighting chamber is equipped with two lamp sockets, mounted on a movable stand and seven inches apart, for the insertion of electric light bulbs. Nitrogen-filled "Mazda" bulbs have been used in the tests. The sockets are so placed that each bulb is opposite a color filter. The electric feed wire furnishes 220 volts A. C., but this is reduced to 110 volts before entering the circuit in which the above lamps are arranged in parallels. Number fourteen covered wire was used.

Chamber B is twenty-three and a half inches long and eighteen inches and a half high. At the outer partition, containing the two filters, it is thirty-four inches wide, while the side towards the center measures sixteen inches. A door in the top allows access to this chamber from above and an aperture leads to Chamber C. This latter opening is nine and a half inches wide by twelve inches high and it is so grooved at the sides as to allow the insertion of a metal partition for the isolation of Chamber B from Chamber C. Each chamber is numbered consecutively 1–8.

In all experiments to date colored glasses, manufactured by the Corning Glass Works of Corning, New York, have been used for the filters. Selenium Red (G24); Selenium Orange (G34); Yellow or Noviol (G38H); "Grass" Green (G401CZ); Dark Blue (G54); Violet (G53C) and Daylite (G90A) represent the seven different types of filters tested.



General view of apparatus.

Chamber three was unlighted and was thus designated as the dark chamber.

Chamber C is fifteen inches high and about three feet across. The floor is two and one-half inches above that of the other chambers. At the top of this chamber is a square door with a central hole for observation. The hole is filled with a cork stopper when not in use.

V. Method of Procedure

Inasmuch as there were many factors to be taken into consideration, regarding the use of this new apparatus, it became necessary to conduct a number of special experiments before deciding upon the customary

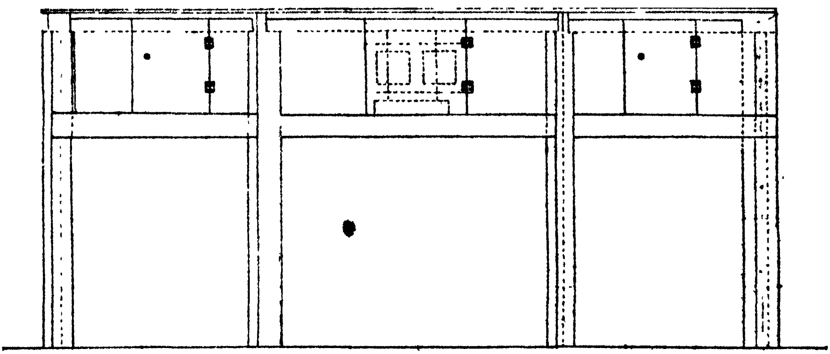


Figure 15.—Drawing of phototropic apparatus from the side. (Each large square represents one square foot).

method of treatment. The main questions at hand included the length of exposure to light rays, the numbers of beetles to be tested, the number of times the same individuals should be used, the value of segregating the sexes and the advisability of keeping them in the darkness before testing.

Thus the procedure varied somewhat during the preliminary tests, but in most of the succeeding experiments it was proved desirable to test the sexes separately, keep the beetles in the dark for half an hour before testing them, handle them as little as possible, use a different set of individuals for each test, run three tests for each experiment and allow a two hour period for their migration to the color chambers.

In general the beetles were gathered at random the first thing in the morning and, after being separated according to sexes, they were placed in some sort of a container. In the meantime the chambers were lighted as desired and the beetles when ready were deposited in the center of Chamber C. The usual two hours were then allowed for them to make

their choice of chambers. At the close of a test the metal partitions were inserted, the beetles removed from the respective color chambers and counted. To better visualize the results the number of beetles attracted were grouped according to the number of the chamber selected. The temperature and humidity were taken at the beginning and conclusion of each test.

VI. Experimentation in 1925 and 1926

Over one hundred experiments were conducted during the summers of 1925 and 1926. It has been impossible to work over the results carefully enough to include them in this paper, but perhaps the following list of the main problems will give the reader a better idea concerning the lines of investigation. 1. Preliminary tests (see Section V above). 2. Sequence of choice, using all filters or with some omitted. 3. Choice of chambers when only two are used. 4. Attraction when only one chamber is lighted. 5. Repetition of choice. 6. Effect of reduction in candle power (watts). 7. Color choice when the intensity of illumination in all chambers is equalized. 8. Effect of changes in the size and shape of the aperture between Chambers B and C.

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President Arthur Gibson: The next is a paper by B. R. Leach and J. W. Lipp. Mr. Leach read the paper.

A METHOD OF GRUB-PROOFING TURF

By B. R. Leach & J. W. Lipp, *Riverton, N. J.*

Abstract

The use of arsenate of lead mixed with the soil to a depth of three or four inches before seeding, or used in the top dressing on turf already established is described. The method is proving satisfactory in practice. The large majority of fine turf grasses are stimulated in their growth by the present of the poison on the soil.

(Withdrawn for publication elsewhere)

Mr. C. C. Hamilton: I would like to ask Mr. Leach if the treating of the turf with lead arsenate prevents oviposition and for what length of time the turf is proof against grub infestation.

Mr. B. R. Leach: I don't think it prevents oviposition. We have seen plenty of beetles going into poisoned turf. As I said during the talk, we were fortunate in starting some poisoned plats in 1921 and we know from the basis of those plats that it is good for five years, apparently only slightly diminished. How long it will remain good, we don't know.

Mr. C. C. Hamilton: That was at the rate of 1500 pounds?

Mr. B. R. Leach: Yes, 1500 pounds. After you have put arsenate of lead in the soil, there is a certain breakdown, and we figure it amounts to about 500 pounds to the acre, and after that breakdown has occurred, it seems to remain, from the toxic angle, constant over relatively long periods.

President Arthur Gibson: The last paper on the program is by Henry Fox.

THE PRESENT RANGE OF THE JAPANESE BEETLE, *POPILLIA JAPONICA* NEWM., IN AMERICA AND SOME FACTORS INFLUENCING ITS SPREAD[1]

By Henry Fox, *Associate Entomologist, Japanese Beetle Project, U. S. Bureau of Entomology*

Abstract

The apparent total range—here termed the empiric range—consists of two sections, in one of which, the normal range, the insect is continuously distributed, while in the other, the area of discontinuity, it is known only from widely isolated points. Occupation of the normal range has resulted largely from natural spread, while its occurrence in the area of discontinuity is a result of long-distance transfer through artificial agencies. Within the normal range the main direction of spread is eastward, a result which is attributable to the combined action of prevailing winds and topographic influences. The apparent effects of these two factors in conditioning the rate of

[1]Contribution No. 17, Japanese Beetle Laboratory.

spread of the insect are discussed. Maps are included showing the normal range and approximate concentration of the beetles for the years 1925 and 1926.

Since its discovery in this country in 1916 near Riverton, New Jersey, the Japanese beetle has steadily extended its range until the latter now includes parts of six States. The maps hitherto published to show the successive stages in the spread of the pest do not, however, discriminate between that portion of its range in which the insect is of general occurrence and that in which it is known only from more or less widely separated stations, with no clear evidence of its presence anywhere in the intervening territory. The former presumably represents a region populated by the beetle as a result of the more ordinary methods of dispersal,[2] whereas its occurrence in localities widely isolated from this region, as also from one another, can scarcely be explained except as a result of long distance transportation through exclusively artificial agencies.

In the present paper I have chosen to designate that portion of the beetle's range in which it is of general occurrence as its "normal range," while all that portion outside the normal range where, so far as known, the insect is confined to isolated stations, I have termed the "area of discontinuity." The "normal range" plus the "area of discontinuity" constitutes the apparent total range, for which I have selected the term "empiric range." The empiric range is naturally defined by a line passing through the outermost points at which the species has been found, irrespective of whether beetles have or have not been found in the intervening country. It is clear, therefore, that much of the country which is included within the empiric range may include vast areas in which there is no present evidence of the actual presence of the pest. On the other hand, the normal range, as defined above, represents a section of the country in which the insect is more or less uniformly distributed.

Previous to 1923 the empiric range of the beetle, as portrayed on the published maps,[3] closely coincides, even if in all details it is not identical,

[2]By ordinary methods of dispersal I mean besides natural methods, such artificial methods as are conceivably afforded by local motor traffic and kindred methods of travel in a limited district. There seems to be some, not entirely clear, evidence that the natural spread of the beetle throughout its present normal range has been partially aided by motor traffic through the originally infested district. At present it is not possible for us to distinguish between local spread due to this cause and that resulting exclusively from natural causes.

[3]See Smith and Hadley, The Japanese Beetle. U. S. Dept. Agric. Dept. Circ. 363 (1926), facing page 6.

with its normal range. But, beginning with 1923, there ensued a remarkable acceleration of the rate of spread which can only be explained by assuming that some factor of dispersal, not previously operative, had come into play. This factor I find in the fact that in 1922 for the first time the beetles invaded the great freight and shipping centers in the cities of Camden and Philadelphia. As a result of their becoming accidentally imprisoned in freight cars, shipholds and other closed conveyances, beetles would be carried away from these centers with no chance to escape until their conveyance reached its destination. The imposing of an embargo on commercial shipments from these cities at times when the beetles swarmed about in threatening numbers reduced this mode of dissemination of the insect to a minimum. Since it has been hitherto impossible to predict the precise time of occurrence of these invasions, it has happened that occasionally living beetles have been found at a distance in freight cars which had left the city before the embargo could be put into effect. Moreover there has come about, within the past few years, in the heavily infested area, an increased use of motor vehicles to transport farm produce to distant points accessible to this form of traffic. There is, accordingly, good ground for assuming that the sudden leap in the beetle's range which characterized the season of 1923 and which has been a marked feature of its subsequent spread, is not to be attributed to any sudden increase in the innate dispersive capacity of the insect itself, but to the fact that, as a result of these two conditions, neither operative on an extensive scale previous to 1922, its artificial dissemination through these means became factors of major importance in extending the insects' apparent range.

In view of the introduction of this new factor in dispersal, there has come about since 1922 a progressively increasing discrepancy between the total, or empiric, range of the beetles and that which I have defined as its normal range, the former expanding at a vastly greater rate than the latter. For example, in 1926, the empiric range extended northeast as far as Stamford, Connecticut, Ossining, New York, and Hackensack, New Jersey, north to Lake Hopatcong and Phillipsburg, New Jersey, and Easton, Allentown and Milton, Pennsylvania, west to Harrisburg and Gettysburg, Pennsylvania, and south and southwest to Delaware City, Delaware, Baltimore, Maryland, and Washington, District of Columbia. In the same year (Fig. 17) the normal range is approximately limited north and northeastward by such localities as Frenchtown, Kingston, Jamesburg and Freehold, New Jersey, east by the Atlantic Ocean, south by such places as Egg Harbor City, Richland,

Millville and Hancock Bridge, New Jersey, while to the west the same range is roughly limited by a line extending from New Hope, through such localities as Doylestown, Lansdale, Norristown and Media, Pennsylvania, to Wilmington, Delaware.

In the following table are listed the distances to which the normal range of the beetle, as previously defined, has expanded in various directions from the point near Riverton where it was first introduced in this country.

TABULATION OF NORMAL RANGE

Direction	Locality	Distance from Riverton
North	Frenchtown, N. J.	38 miles
North Northeast	Kingston, N. J.	33 "
Northeast	Jamesburg, N. J.	38 "
East Northeast	Freehold, N. J.	41 "
East	Toms River, N. J.	43 "
East Southeast	Barnegat, N. J.	45 "
Southeast	Port Republic, N. J.	43 "
South Southeast	Richland, N. J.	35 "
South	Millville, N. J.	42 "
South Southeast	Shiloh, N. J.	41 "
Southwest	Hancock Bridge, N. J.	42 "
West Southwest	Wilmington, Del.[1]	33 "
West	Newtown Square, Pa.	22 "
West Northwest	Norristown, Pa.	21 "
Northwest	Lansdale, Pa.	24 "
North Northwest	Doylestown, Pa.	24 "

[1]If, as has been done on the map, the 1926 limits in this direction are extended as far as Delaware City, this distance becomes 43 miles. As in 1926 no beetles were found anywhere in Delaware south of Wilmington, except at New Castle and Delaware City, it seems doubtful if we are justified in extending the normal range for that year below Wilmington.

The fact most clearly brought out in this table is the retardation of its westward as compared with the eastward expansion of the insect's range. In general, this is equivalent to saying that its progress in Pennsylvania has been considerably less rapid than in New Jersey.

To account for this difference in the rate of spread of the beetle in the two states, the factors which most obviously suggest themselves as possible explanations are wind direction and topographic features.

In favor of wind direction as a factor in conditioning the dispersal of the beetle may be mentioned the coincidence between the main direction of its spread and the general prevalence in the region, during the season of the beetle's activity, of west and southwest winds. These are also warm winds which ordinarily stimulate the insect to increased activity and thus increase its chances of dispersal. As our field observations

indicate that the beetle in flying ordinarily goes with the wind, provided the mechanical action of the wind is not counteracted by influences of an opposing nature,[4] it seems but reasonable to assume that conveyance by the wind is not without influence on its rate of spread.

As an objection to this view may be urged the fact, as shown in the table, that the distance the beetle has covered in its spread from its original center to the present limits of its normal range has been nearly, if not quite, as great in both a direct northward and a southward direction as it has been in an eastward direction, at least, so far as its range in New Jersey is concerned. This objection may perhaps be met in part by considering two features connected with the eastward movement. One of these is the relative concentration of the insect near the limits of its normal range, the other the influence of a forest cover on the rate of spread.

As regards the first mentioned matter, the available evidence indicates rather clearly that there is a much greater tendency for the beetles to occur in greater numbers at certain points close to the eastern limits of the insect's range than is the case at equally favorable localities close to its northern and southern limits. This fact, it is true, tends to lose some of its force when it is borne in mind that this eastward movement of the mass of the beetles may have been very considerably favored by the heavy summer tourist travel to the seashore resorts. But this objection is again partly nullified by the fact that the eastward spread of the beetle, in some instances, has been more marked along some

[4]Of the opposing influences the more potent are chemotropic responses by the insect to certain odors given off by the vegetation and conveyed to the insects by the wind. Smith and Hadley in a recent publication (loc. cit., p. 33) assert that the beetles normally fly against the wind. This is true if we limit our observations to stations where the beetles are in a favorable position to receive such stimuli as those mentioned. Under such circumstances the flight of the insects against the wind is a most impressive phenomenon as the present writer can testify from his personal field observations. But, when the beetles are observed in other situations where they are remote from such influences, nothing like a definite response to wind direction is observable, and under such conditions their flight is essentially aimless, the general drift being, however, with the wind. That the mechanical action of the wind is not without influence on the direction of flight is further evidenced by the observation that the so-called migratory flight of the beetle which recurs at sundry intervals into the business centers of Philadelphia invariably coincides with periods during which for the time being the wind has shifted about to the east. Such east winds doubtless serve to convey a much greater number of beetles from their breeding grounds in New Jersey across the Delaware into the city than succeed in reaching the latter during the times when the prevailing westerly breezes hold sway.

comparatively unfrequented lines of travel than it has along certain other lines where the seashore motor travel is extremely heavy.

As regards the second point raised as influencing the eastward rate of advance, namely, the influence of a forest cover, it is well known that the greater part of the interior of southern New Jersey forms a heavily timbered region known as the Pine Barrens. While a heavily forested region does not interpose a very formidable barrier to the Japanese beetle, it offers relatively few favorable breeding or feeding areas and hence acts as a retarding influence on the rate of advance. It is well known that the Japanese beetle favors an open, campestral type of country and it is a matter of observation in the New Jersey Pine Barrens that it normally occurs in considerable numbers only in areas where the forest has been cleared off and the land converted into farms, gardens and other open spaces. It seems highly probable that, if the Pine Barren region of the State had presented throughout conditions similar to those in the Delaware Valley section, the eastward advance of the beetle would have taken place much more rapidly than has been the case.

While there appears to be much to favor wind direction as affording an adequate explanation of the present eastward trend of the normal range of the beetle, there are good grounds for believing that other factors have been involved, of which the more important may be grouped under the general head of effects of topography.[5] That the rapid spread of the Japanese beetle is favored by a type of topography which is characterized by such features as extensive tracts of nearly level, or at most gently rolling, country, along with deep, friable soils, capable of retaining throughout the year a fairly high water content, yet so situated as to allow ready aeration, has long been noted. Such a type of topography is extensively represented in the Coastal Plain section of New Jersey, to which section the normal range of the beetle in that State has until quite recently been entirely confined.

On the other hand, with its spread across the Delaware into Pennsylvania, the beetle had but a few miles to travel before it reached the Fall Line which marks the boundary between the Coastal Plain and an

[5]The writer realizes that topography *per se* does not constitute a factor conditioning dispersal; it is, strictly speaking, the complex of conditions depending on topography which form the more immediate agencies influencing distribution. Thus, topography may have a profound influence in determining such matters as the composition, texture, depth and moisture content of the soil and these in turn may profoundly influence the distribution of the various forms of plant life on which the beetles or their larvae feed.

upland region which physiographically is distinguished as the Piedmont Plateau. The latter is a region of considerably greater altitude than the Coastal Plain, with a more rugged topography in which areas of level or nearly level country are of localized occurrence and limited extent. The soils of the Piedmont region are also quite different. With the

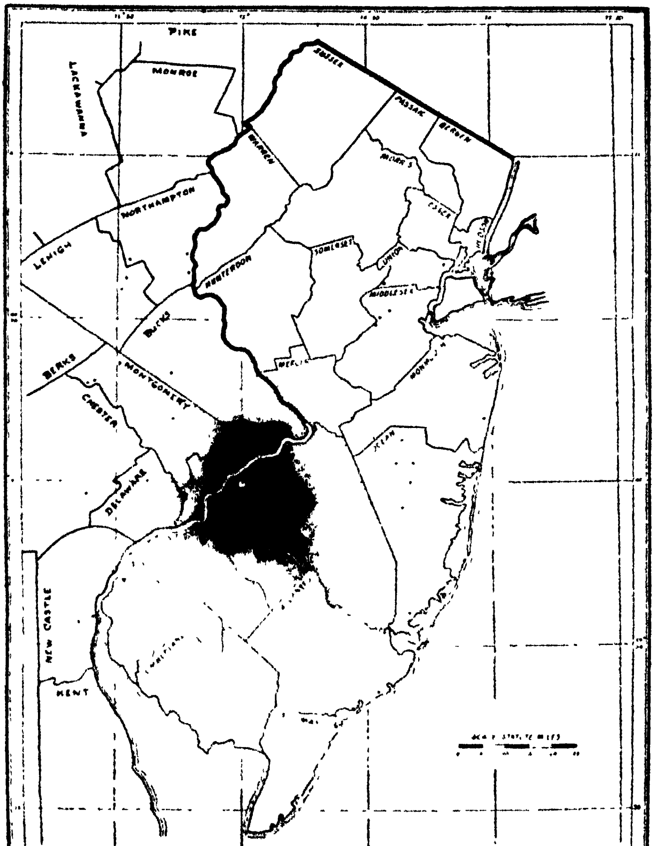

Fig. 16.—Relative frequency of the Japanese beetle in its distribution area in 1925.

exception of the alluvium of the river bottoms, they are prevailingly stiff heavy clays and loams, often of little depth, especially on steeper slopes, and frequently quite stony. These are the conditions to which the beetle has been forced to adapt itself in the westward extension of its range through Pennsylvania, and that it is experiencing at least a certain measure of difficulty in doing this is indicated by the fact that in certain

Piedmont localities, as, for instance, about Willow Grove, where it has been known since 1923, it is to-day scarcely more in evidence than it was

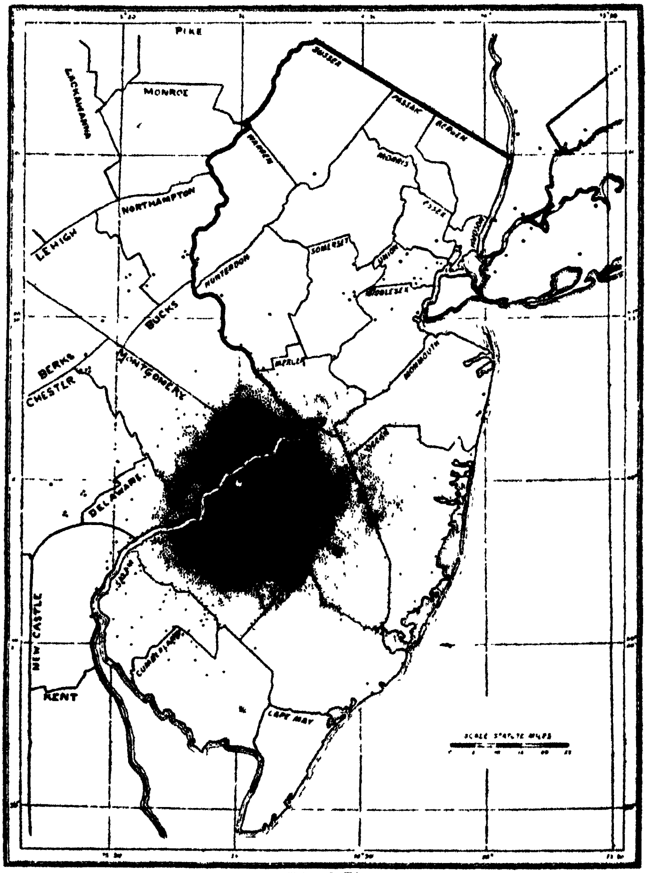

Fig. 17.—Relative Frequency of the Japanese beetle in its distribution area in 1926.[6]

[6]In both this and the preceding figure the density of the dots is roughly proportional to the density of the beetle population in different parts of its normal range. The normal range is defined by the outermost row of dots limiting the area in which the dots are placed at regular intervals apart. The small circular blank space within this area represents the original center from which the beetle began its spread. The solid black area represents the region in which the beetle is abundant enough to be economically injurious.

The dots scattered about at varying intervals in the section outside the normal range represent localities where beetles have been found in the "area of discontinuity." Certain localities in the latter (e. g. Reading, Harrisburg, Milton, etc.) are too remote to be included in the maps.

when first encountered in those places. On the other hand, in most Coastal Plain localities rarely more than two years elapsed following its appearance before it had reached a point where its destructiveness was obvious to even the casual observer.

While there would appear to be much to favor the view that influences arising from topography are capable of accounting for the delay which the beetle has experienced in its advance in Pennsylvania, we need to be on our guard against a too hasty acceptance of this explanation. The main ground for an exercise of caution in this matter lies in the fact that the whole subject of the adaptability of the Japanese beetle to Piedmont environmental conditions is still under investigation and that our present knowledge is not of that detailed, analytic character which would enable us to assign to each possible factor its proportionate share in conditioning the spread of the insect. Moreover, we do not have at the present time any clear criterion for distinguishing between dispersal controlled primarily by the wind and that which is conditioned chiefly by topography. In view of this uncertainty we are compelled to treat each possible explanation as nothing more than a suggestion whose validity is to be tested through future investigation. From the point of view of our present knowledge of the behavior of the Japanese beetle, the factors which seem to offer most promise as influencing its natural spread are direction of prevailing winds and topography.

For the sake of comparison there is included in this paper a chart (Fig. 16) showing the distribution and relative concentration in different parts of its normal range of the Japanese beetle as it was in 1925. By comparison with the similar chart (Fig. 17) for 1926 one can form an idea of the yearly amount of spread. One noteworthy feature shown by the charts, which has not hitherto been mentioned in this paper, is the striking retardation of the spread which is shown through the heavily built-up sections of Philadelphia, where suitable feeding and breeding grounds for the beetle are naturally reduced to a minimum. Paradoxical as it may seem, a large city, like Philadelphia, may have two opposite effects on the dispersal of the beetle. It puts a brake on the local extension of the range, but, by increasing the opportunities for long distance conveyance of the insect through artificial agencies, it serves to accelerate the extension of its empiric range.

(After the reading of Mr. Fox's paper, which closed the program of papers, the final business was transacted which appears in the business proceedings.)

A PRELIMINARY REPORT ON A GRASS-ROOT MEALYBUG (*RIPERSIA RADICICOLA* MORRISON) AFFECTING SUGAR CANE IN CUBA[1]

By C. F. STAHL, *Chief Entomologist*

ABSTRACT

A typical root-feeding mealybug (*Ripersia radicicola* Morrison) is found well distributed over the Island of Cuba on the roots of grasses and sugar cane.

The mealybug is probably a native species which inhabits the roots of grasses and has adapted itself to sugar cane.

"Grass-root mealybug" is suggested as the common name for this insect in preference to "sugar cane root mealybug," inasmuch as wild grasses are the primary host plants.

The area of injury does not coincide with the area of distribution. Serious injury occurs in soils subject to drought where the mealybug appears to be only one of several factors unfavorable to the growth of the plant.

The use of legume cover crops in areas where the grass-root mealybug is a serious pest, to improve the soil and suppress the grass hosts, is under consideration.

During the past two years considerable interest has been manifested in a mealybug found feeding upon the roots of sugar cane in several localities in Cuba. This interest has been intensified by the fact that the insect was reported as undescribed, which led some to believe that it was a pest recently introduced into Cuba. An effort has been made to obtain as much information concerning this insect as other work in progress would allow. The purpose of this paper is to summarize these observations and to discuss certain points that they raise.

"Mealybug" and "chinche harinosa" are terms familiar to all who have had experience in growing sugar cane. Besides the mealybug under discussion, which occurs on the roots of grasses and sugar cane, two species of stalk mealybugs have been encountered in Cuba. They are widely distributed. They are red or gray soft-bodied insects, covered with a white powdery or fluffy substance, occurring in clusters, usually at the nodes under the leaf-sheaths of the cane stalks. It is the white powdery covering that is responsible for the common names "mealybug" and "chinche harinosa."

While the general appearance of mealybugs feeding on a plant is such that they may be easily recognized as a group, it is not so easy to distinguish between the different species. The common stalk forms may be found on the cane from the time it starts to germinate, and they are often seen beneath the surface of the ground, clustered around a germinating bud, or at the base of growing stalks. It would not, there-

[1]Scientific Contributions No. 8, Tropical Plant Research Foundation. From the Cuba Sugar Club Experiment Station, Central Baraguá, Cuba.

fore, be surprising if another species feeding on the roots was thought to be identical with the stalk species and if the fact that this other species constituted a potential pest had been entirely overlooked. Such seems to have been the case.

No reference to the occurrence of a root-feeding mealybug on sugar cane in Cuba has been found in the available published reports prior to 1924. However, mealybugs were observed on the roots of sugar cane growing at Central Stewart in 1916 by Mr. J. T. Crawley, who was at that time director of the Agricultural Experiment Station at Santiago de las Vegas. As this observation was never published, Mr. Crawley has kindly furnished his notes, which are quoted as follows:

"October 3, 1916. Fields are very uneven and there are many spots near the roads that are not thriving. Numbers of mealybugs, comejens and beetle grubs were found at the roots of cane. Easy to pull up. Probably 5 to 10% of the old fields so affected. Mealybugs are most abundant, both on the cane and at the roots of cane examined." Mr. Crawley stated that he could remember that the mealybugs in question were often noted on the smaller roots, but he did not attach any particular significance to the fact at that time. It is very probable, in the light of what is now known concerning the distribution of the grass-root mealybug, that Mr. Crawley observed this insect at that time. It can therefore be stated with reasonable certainty that the root-feeding mealybug was present on the roots of sugar cane in some districts of Cuba as early as 1916.

In October, 1924, attention was called to a mealybug designated as *Ripersia* sp. (2),[2] which was found infesting the roots of sugar cane in Cuba. Ballou (1, p. 46), in his list of scale insects and mealybugs of Cuba, published in April, 1926, includes *Ripersia* sp. as having been collected at Camagüey by Bruner in 1923. Van Dine (6, p. 11–12) records *Ripersia* sp. in his list of sugar cane insects and mentions its occurrence on the roots of numerous grasses in the Provinces of Oriente and Camagüey. Myers (5, p. 99) also mentions *Ripersia* sp. as having been observed at Soledad in Santa Clara Province. Finally, in October, 1926, Morrison (4) published a description of the species under the name *Ripersia radicicola* n. sp., basing his description on material submitted from the Provinces of Oriente, Camagüey, and Santa Clara.

The tendency at first was to refer to this insect as "the sugar cane root mealybug," a name which would indicate that sugar cane was of primary importance as its host plant. As will be shown later, this does

[2]Numbers in parenthesis refer to references listed at the end of the paper.

not seem to be the case. The common name "grass-root mealybug" is suggested because of the importance of wild grasses as host plants.

If this root mealybug limited its feeding to the roots of sugar cane, or even showed a preference for them, it might appear to be a pest which had been introduced in some way as a result of the extension of cane planting. It has been repeatedly observed that many different species of grasses are infested, and in many cases it is evident that the infestation is in no way related to the planting of sugar cane. In fact, infestations have been noted on the roots of grasses growing adjacent to cane fields in which the roots of cane stools were found upon examination to be uninfested. In a few cases mealybugs have been found on grasses growing in areas far removed from cane fields.

On the basis of these observations it is reasonable to assume that the root mealybug is a typical grass-root feeding species, that it is probably native or at least that it has been present in Cuba for a long time, and that under changing cultural conditions, brought about by the rapid extension of cane plantings, it has spread to the roots of sugar cane.

The distribution of the grass-root mealybug over the Island has not been fully determined. It was first noted by the writer on the roots of grasses and sugar cane growing on the plantation of Ingenio Jobabo. The infestations there were limited to areas where the soil was comparatively light and well drained. Records were made of infestations on the roots of grasses growing on ditch banks, in guardarrayas, along the edges of cane fields, and, in some cases, well within the cane fields. When the infestations were found on the roots of sugar cane, their location often indicated that the source might have been the adjacent guardarrayas, in as much as the areas infested were usually small semi-circular patches spreading from the edges of the fields. This was especially true where the guardarrayas had been planted to sweet potatoes (boniatos) and the natural grass hosts had in this way been suppressed. Later, more widespread infestations were found in the Province of Camagüey.

The following fragmentary records are given to indicate the localities in which the grass-root mealybug has been found. These records are taken from the survey reports made by Dr. Wm. H. Weston, Jr., Dr. R. V. Allison, and other members of the staff of the Tropical Plant Research Foundation. While these records indicate the presence of the mealybugs in the localities observed, they do not furnish information regarding the abundance or extent of the infestations, nor do they show the limits of distribution. The authority for the observations is given in parenthesis.

ORIENTE PROVINCE

Central Isabel, Media Luna (Allison)
Ingenio Jobabo (Stahl)

CAMAGÜEY PROVINCE

Central Agramonte (Weston and Van Dine)
Central Baraguá (Stahl)
Central Cunagua (Van Dine)
Central Estrella (Allison)
Central Florida (Weston)
Central Francisco (Allison)
Central Jagueyal (Van Dine)
Central Jaronú (Poey)

SANTA CLARA PROVINCE

Central Hormiguero (Faris)
Central Portugalete (Allison)
Central Soledad (Myers)
Central Tuinucú (Weston)

As has been mentioned before, the grass-root mealybug has been found on the roots of a large number of grasses. The following is a list of these plants as far as they have been determined.

Cenchrus echinatus	guizazo
Valota insularis	barba de indio
Echinochloa colonum	grama pintada
Syntherisma sanguinalis	pata de gallina
Panicum reptans	grama de Castilla
Panicum fasciculatum	súrbana
Cynodon dactylon	hierba fina
Eleusine indica	grama de caballo
Sporobolus indicus	espartillo
Chloris ciliata	
Chaetochloa geniculata	rabo de gato
Leptochloa filiformis	pata de gallina
Sorghum spp	millo
Zea mays (corn)	maíz
Saccharum officinarum	caña de azúcar
Cyperus sp	cebollita

Most of the grasses were determined by Dr. M. N. Walker, formerly Pathologist at the Cuba Sugar Club Experiment Station, and the identifications were confirmed by Dr. A. S. Hitchcock of the United States Department of Agriculture, who also determined *Chloris ciliata*. The identification of *Sporobolus indicus* was made by Dr. J. A. Faris, Chief Pathologist of this Station. Dr. Weston reported *Cyperus rotundus* as infested with root mealybugs at Tuinucú, and Mr. B. T. Barreto

reports that he has collected the grass-root mealybug on the roots of Johnson grass (*Holcus halepensis*).

It will be noted that the majority of the grasses which have been found to be infested are annuals. This does not necessarily mean that the perennials are not host plants, but it indicates that the annual grasses are of primary importance as hosts. Roots of such grasses as paraná (*Panicum barbinode*) and Guinea grass (*Panicum maximum*) growing in infested areas have been examined many times, but the root mealybug has never been found on them.

It is not possible with the literature available to discuss in detail the relation between the grass-root mealybug and other root-inhabiting mealybugs. A number of reports have, however, been noted in which the occurrence of mealybugs on the roots of sugar cane and grasses in other countries has been mentioned. Lefroy (3, p. 759) mentions *Ripersia sacchari* Cr. as living on cane as well as on rice and grasses in India but does not state that it is found on the roots. *Ripersia internodii* Hall, reported by Willcocks (7) from Egypt, appears to be a species that feeds on grasses and sugar cane, both above and below the ground. It is, however, said to feed on the nodes and internodes of sugar cane. In the same report *Pseudococcus variabilis* Hall is mentioned as a common grass-root feeding species which is found well up on the jointed canes and around the nodes of sugar cane. *Pseudococcus trispinosus* Hall is also reported as feeding on the roots of sugar cane and grasses. From these scattered reports it will be seen that it is not uncommon to find the roots of grasses infested with mealybugs, as well as sugar cane.

As a rule it is not difficult to recognize the grass-root mealybug in the field. Perhaps the one species most apt to be confused with it is the gray sugar cane mealybug (*Pseudococcus boninsis* Kuwana), found commonly on the stalks of sugar cane in Cuba. This stalk mealybug may be distinguished from the root mealybug in several ways. It is somewhat larger, is covered with a more dense waxy-like secretion, and is flatter. The root species is distinctly globular in shape, and the conspicuous pink tinge can be seen through the sparse powdery secretion. Perhaps, however, the best way to distinguish between the two species is by means of their feeding position on the plant. The stalk mealybug is usually found on the stalk above the ground, but when it is found below the surface of the ground it has always been in the crown at the base of the stalks or around the germinating buds (Pl. 13, Fig. 2, 3). The root mealybug, on the other hand, has always been found on the roots and usually on the small rootlets, which spread out some distance from

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Grass Root Mealybug, *Ripersia radicicola* Morrison.
1, Mealybugs clinging to the roots of sugar cane. (Original).

Sugar Cane Stalk Mealybug, *Pseudococcus boninsis* Kuwana (Van Dine).
2, Mealybugs on node of sugar cane after leaf sheath has been removed.
3, Mealybugs clustered about the base of young cane stalks.

the base of the plant. The stalk species has not been found on grass, but it may be present on some of them, especially the large cultivated types. When a plant is pulled up some of the root mealybugs usually cling to the roots by means of their mouth parts, which they insert in the tissue of the roots (Pl. 13, Fig. 1).

There are other underground mealybugs which are commonly found on weeds and grasses in Cuba. A common weed, romerillo (*Bidens* sp.) is frequently found to be infested with mealybugs below the surface of the ground, and it has been reported that romerillo is responsible for the presence of the grass-root mealybugs in the cane fields. The species feeding on romerillo is found on the underground portion of the stems rather than on the roots, and it has not been found on the roots of sugar cane. Several grasses have been found to be infested in the crown by the romerillo species, which Dr. Morrison has determined as *Pseudococcus virgatus* Ckll.

In common with other mealybugs, the grass-root mealybug is always attended by ants, which care for and protect them in return for a sweet substance known as honeydew secreted by the mealybugs. The most common attending ant is a small, inconspicuous, almost black species, which has been determined by Dr. W. N. Mann of the United States Department of Agriculture as *Tapinoma melanocephalum* Fabr. This ant, whose nests have been found at the base of the infested plants, is very assiduous in its attentions, and when the mealybugs are disturbed will pick them up and scurry about in search of a hiding place for them. It is very probable that these ants are largely responsible for the spread of the mealybugs. In fact, plants grown in pots for experimental purposes have become infested in such a way as to show conclusively that the mealybugs had been placed on the roots by the ants. Myers (5) reports a large ant (*Odontomachus haematoda insularis* Wheeler) in close association with the grass-root mealybug in the Soledad (Cienfuegos) area. Occasionally the fire ant, hormiga brava (*Solenopsis geminata* Fabr.), has been found associated with the grass-root mealybug, but the fire ant is more commonly found attending the stalk mealybugs.

There is some question in regard to the amount of injury that should be attributed to the grass-root mealybug. In areas of light soil, under drought conditions, this insect may cause severe injury to sugar cane. The damage is apparent where other factors, especially soil and drainage conditions are unfavorable to the growth of the plant. In many cases the plants are killed in small areas. Under these conditions it has been almost impossible to obtain a new stand of cane. An uneven stand of

cane has been observed in many Cuban fields, the vacant areas having grown up to grasses, which are often infested with root mealybugs. Grasses growing in these vacant areas perpetuate and augment the infestation, and consequently the areas become no longer suitable for growing cane. Unless the mealybugs are suppressed, or the grasses, or the conditions that favor their development are corrected, it is difficult to replant these areas. On the other hand, under favorable growing

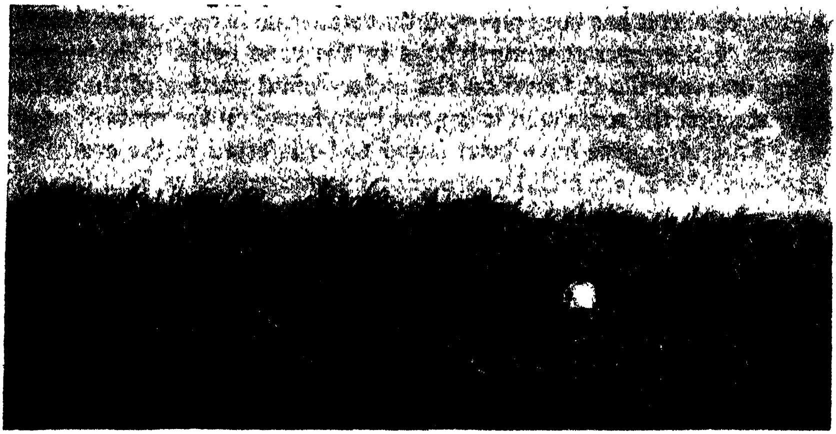

Fig. 18.—Plots of Sword Beans (*Canavali gladiata*) in the foreground, showing the vigorous growth and excellent cover made by this plant. (Original).

conditions, vigorous cane plants have been found to be heavily infested with root mealybugs. Often fields are found in which the plants are comparatively heavily infested but do not show any visible effect of the infestation. In other words, the area of injury from root mealybug does not coincide with the area of its distribution. It is probable, therefore, that the severe injury which follows a heavy infestation of the grass-root mealybug results from a number of unfavorable factors, of which the mealybug is only one.

The fact that so many grasses serve as hosts for the grass-root mealybug complicates the problem of control. Any expensive method of soil treatment would obviously be impractical if the importance of the presence of the grasses was overlooked. There is some evidence showing the relation of ants to the distribution of the mealybugs which would indicate that the reinfestation of treated areas will be a serious problem as long as there are grasses growing in the vicinity. In view of these considerations and until a more careful study has been made of all the

factors concerned, soil fumigation does not seem likely to be a practical method of control.

The possibility of utilizing certain legumes for cover crops, as a means of improving the condition of the soil and suppressing the grasses in badly infested areas, has been considered. Certain legumes, such as sword and jack beans, make a rapid, dense growth which seems to be very effective in keeping down weeds and grasses (Fig. 18). These beans are not host plants for the grass-root mealybug. Their value in farm practice as a means of soil improvement has long been recognized. A series of small plots has therefore been laid out in a heavily infested area where the injury is apparent. By means of these plots, observations may be made as to the efficiency of cover crops in suppressing the grass host plants of the mealybug and thus starving it out of the areas. The value of such crops as a means of correcting the poor soil condition can be determined, and also the growth habits of the beans under different seasonal conditions. It is hoped that observation of these plots may give suggestions which may later result in definite recommendations for the improvement of areas badly infested with mealybugs and lead to the discovery of practical control measures.

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INSECT REVIVAL AFTER FUMIGATION[1]

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ABSTRACT

Saw-toothed grain beetle (*Oryzaephilus surinamensis*) adults and the Indian-meal moth (*Plodia interpunctella*) larvae fumigated with carbon disulphid at atmospheric pressure revive under certain conditions as much as ten and fifteen days, respectively, after treatment. Several larvae of the latter species which revived a week or more after fumigation subsequently emerged as adults. With these species, under the conditions outlined, accurate results cannot be secured by final examination twenty-four to forty-eight hours after fumigation.

INTRODUCTION

Casual reference to entomological literature shows that few data are available concerning two points of procedure in experimental fumigation: namely, the length of time elapsing between fumigation and determination of results, and the revival capabilities of treated insects. The references bearing upon these questions which were encountered in our cursory survey of the literature are summarized below.

Swain (*8*)[2] states that, in certain experiments with hydrocyanic acid gas, adult lady beetles (*Hippodamia convergens* Guer.) were used because it could be determined within a comparatively few hours after fumigation whether or not they were alive.

Smith (*7*), in reporting the result of cyanide fumigation of house number 17 for the control of bed bugs, states that the insects in the vials in the fumigated enclosure were all dead at the end of the exposure, while those in the vials outside were all alive.

Neifert and Garrison (*4*), in comparing the toxic action upon insects of certain other gases with that of hydrocyanic acid gas, indicate their method of determining the kill in the following sentence: "The observations were begun when the insects were removed from the fumigatorium, and continued up to the time the percentage of dead became constant for any two successive days." With reference to insects[3] treated with chloropicrin the statement is made that, on removal from the fumigatorium, "all the insects were apparently dead, and none of them revived during a period of several days."

Neifert *et. al.* (*5*), using several species of weevils and employing some one hundred compounds, indicate the interval between fumigation and examination in the following terms: "After standing for

[1]This paper was prepared in January, 1927.

[2]Italic numbers in parentheses refer to Literature Cited.

[3]*Tribolium ferrugineum* Fab., *Calandra oryza* L., and *Plodia interpunctella* Hbn.

twenty-four hours at room temperature (21° to 32°C.), the percentage of dead weevils was determined. (All specimens were examined after twenty-four hours, and also after forty-eight hours, to avoid reporting as dead those which might have been only stupefied)." These writers do not indicate whether any stupefaction was thus discovered.

Schenk (*6*) indicates the procedure employed with test lots of certain grain insects fumigated with hydrocyanic acid gas as follows: "The boxes were removed at the close of the fumigation. The insects were examined under a hand lens and any which exhibited signs of life were recorded as alive and discarded. A further examination was made at the end of a twenty-four hour period. Such insects as then showed signs of life were recorded as stupefied and the balance recorded as dead. This twenty-four hour period was chosen after it was found that results were no different than those observed at the end of a seven-day period." This writer has tabulated the percentages of stupefied insects.

Aside from a general failure of investigators to mention the length of time from fumigation to final examination, the above references show considerable variation among those recording their procedure in this regard. Thus, the methods vary from examination immediately after the close of the exposure to as much as forty-eight hours later, and, in one instance, the final count was not based upon a constant interval but upon constancy of the percentage of (*Tribolium ferrugineum* Fab., *Calandra oryza* L., and *Plodia interpunctella* Hbn.) dead. However, the writers believe the usual procedure to be characterized by allowing an interval of twenty-four hours between the end of the exposure and the final determination of effectiveness. Under such circumstances it is but natural that scant reference should be found to the power of revival of fumigated insects.

In the fall of 1924, investigation of the effectiveness of various fumigation methods employed by dried-fruit packers in California was undertaken. During the following winter the senior author discovered that some of the insects which appeared to be dead on the first day following fumigation subsequently became active. This finding indicated the likelihood of error attaching to results secured from examinations made twenty-four hours after treatment, and necessitated inquiry as to the most appropriate interval after fumigation for making the final count. Accordingly, fumigated insects were thereafter subjected to protracted examination. In this manner there have been assembled, incidental to the study of various fumigation operations, considerable data on revival and the length of time between treatment and the final count in relation to accuracy of results.

All results here recorded relate to the adult and larval stages of the saw-toothed grain beetle[4] and the Indian-meal moth,[5] respectively. The experiments presented include six fumigations of railway cars, seven of packing-plants, and two of other chambers. In all instances carbon disulphid was used, but in two of the car fumigations carbon dioxide was employed in conjunction with it.

Methods of Examination

The initial examination of fumigated insects was ordinarily made on the same date the exposure ended, this being termed the zero day. In such cases the examination was usually completed within three hours after treatment, and never exceeded five hours. At the first inspection the insects were removed from the cheese cloth bag, in which they had been fumigated with a small quantity of fruit, and placed in a pan for counting. The living individuals were then placed in one vial and supplied with uncontaminated fruit, while those exhibiting no evidence of life were similarly placed in another vial. The insects were always handled with camel's hair brushes. At later examinations the insects were removed from a vial to a pan for inspection. Adjustments between the two vials of a given test-lot were then made in accordance with changes which had now become evident; that is to say, individuals in the dead batch manifesting unmistakable signs of life were removed to the vial containing living individuals, while any in the latter vial which now appeared to be lifeless were transferred to the vial containing the apparently dead individuals. Records of all such exchanges were kept.

In such a work as this it is essential that a constant basis of differentiation be applied to each insect for the determination of life or apparent death. The distinction here used was based upon the necessity of observing some movement of the insect before life could be attributed to it. In the event of rapid revival to such a degree as to permit the locomotion normal to the particular stage of a species there was, of course, no need to resort to special tests for the determination of an individual's status. It so happens, however, that the first movements of reviving insects are often slight, sometimes necessitating the use of a hand lens as an aid to accurate decision. While there are other criteria as to the condition of an insect in its active stages, movement must be the ultimate gauge of its possession of life.

Doubtful adults of Oryzaephilus were tested by exhaling the breath upon them several times. The proximity of the mouth to the insects and

[4]*Oryzaephilus surinamensis* Linné, hereafter referred to as Oryzaephilus.
[5]*Plodia interpunctella* Hbn., hereafter referred to as Plodia.

the volume of breath was always sufficiently limited to prevent the condensation of moisture on the surface supporting the insects. The response of living beetles to this test was movement of the legs and antennae. The testing of doubtful Plodia larvae was somewhat more intricate. Here the thigmotropic response was more valuable. The well-known response of normal larvae to touch was approximated by fumigated larvae only in instances where the effect of the treatment had not been severe, or after the early stages of recovery had been passed. After lightly touching doubtful larvae at several points on the dorsum with the smooth, blunt butt-end of a camel's hair brush, the first movements were usually noticed in the head region and consisted of movements of the mouth-parts, the legs, or very slight movements of the head, either vertically or horizontally.

Before fumigation and during the period of protracted examination following fumigation the insects were kept at normally-fluctuating room temperature, it being believed that such handling minimized the influence of extraneous factors upon revival, such as would have obtained with retention of the fumigated insects at carefully-controlled uniform temperatures. The principal difference here involved was that before fumigation the insects were subject to the moderating effects of small masses of dried fruit, while after treatment they were confined in loosely-stoppered vials with only two or three raisins. This feature of the handling, as discussed elsewhere, was no doubt prejudicial to revival and therefore in favor of conservative results.

Because of the number of insects included in each experiment it was entirely impracticable to retain the revivals and subsequent deaths from each examination as separate units for further observations, despite the great desirability of so doing. Such handling would have been productive of two important results. First, the extent of ultimate survival would doubtless have been affected for it has often been observed that, even with untreated individuals, the percentage of mortality under crowded conditions is very considerably increased. Second, the retention of each day's revivals as separate units would have permitted calculation of the percentage of ultimate survival of those which revived, as well as a determination of their normalcy.

Counts of Fumigated Insects Over a Protracted Period

With the exception of the fumigations in the sulphur house and the trash fumigator, the following data are drawn from experiments conducted under commercial conditions. Since this paper has to do solely with the phenomenon of insect revival, the pertinent conditions are

merely outlined, with no attempt at discussion of the merits or demerits of the various operations. It should be stated, however, that the different lots of insects within a given experiment represent differently located batches of insects within the fumigated enclosure. Each of these lots was enclosed in a single thickness of cheese cloth and placed in the center of the specified unit of the lading or contents.

A. RAILWAY CAR FUMIGATION

Experiment I

Fumigation of	Railway car	Lading	25-lb. boxes bulk raisins, with glasine paper liners
Charge of CS_2	27.9£ 1000 c.f.		
Exposure	17 hrs., 45 min.	Temp. (Fahr.)	Start, 65; end, 49
Insect	Oryzaephilus adults	P.c.Rel.Hum.	Start, 66; end, 86
		Date	March 5–6, 1926

Table 1A. Record of Protracted Counts

Lot No.	Original count Condition	0 day	Nature of change	Subsequent changes: Number of individuals changing status after— 1 day	2 ds.	3 ds.	4 ds.	5 ds.	6 ds.	7 ds.	8 ds.	9 ds.	10 ds.	11 ds.	12 ds.	13 ds.	14 ds.	Totals
1	Living	0	Deaths	0	1	4	2	0	5	0	9	5	4	5	2	2	7	46
	Dead	131	Revivals	7	26	7	8	7	12	0	1	2	3	3	0	0	0	76
2	Living	0	Deaths	0	9	3	3	6	7	4	1	8	4	0	3	3	1	52
	Dead	147	Revivals	133	12	0	0	4	5	3	0	2	2	0	0	0	0	161
3	Living	0	Deaths	0	0	2	4	4	2	6	6	6	6	7	3	1	8	55
	Dead	137	Revivals	9	49	11	13	6	6	3	1	0	0	0	1	0	0	99
4	Living	0	Deaths	0	3	2	0	5	2	4	5	10	5	6	8	5	4	59
	Dead	152	Revivals	19	47	15	19	16	1	2	0	1	3	0	0	0	0	123
5	Living	0	Deaths	0	0	3	5	14	6	9	7	13	5	5	14	5	7	93
	Dead	185	Revivals	49	70	31	14	1	3	2	3	1	0	0	0	0	0	174
6	Living	0	Deaths	0	2	5	4	4	3	9	9	5	10	5	2	2	0	60
	Dead	130	Revivals	51	44	14	4	4	0	1	1	0	0	0	0	0	0	119
7	Living	0	Deaths	0	0	0	1	1	1	3	0	3	2	4	4	5	2	26
	Dead	119	Revivals	0	8	1	6	7	0	9	7	1	5	0	0	0	0	44
Totals	Living	0	Deaths	0	15	19	19	34	26	35	37	50	36	32	36	23	29	391
	Dead	1001	Revivals	268	256	79	64	45	27	20	13	7	13	3	1	0	0	796

Table 1A shows the numbers of living and apparently dead Oryzaephilus adults in each of the several test lots on the day the exposure ended, and presents a record of the daily changes in status over a 14-day period. Analysis of this table reveals, in the main, two opposing and overlapping trends. The totals show abundant revival, beginning early and diminishing rapidly. Indeed, this trend is largely restricted to the first week following fumigation. Subsequent death, on the other hand, builds up from a small beginning and extends over the entire period. Thus, for a time, revivals outnumber subsequent deaths; later, subsequent deaths are in the majority. The totals establish this change as taking place on the seventh day.

By virtue of the different locations of the several test lots, affecting the degree of exposure to the fumigant, deviations from the average trend are to be expected. Nevertheless, examination of the records of individual lots shows a general coincidence with the average trend just noted, lots 2 and 7 being the exceptions. In lot 2, revival on the first day was so nearly complete as to leave few beetles for later revival, thus operating to establish the excess of subsequent death over revival on the third day. Lot 7 was characterized by light, prolonged revival. Permanent excess of subsequent death over revival obtained on the eleventh day. These conditions, together with the ultimate excess of revivals over subsequent deaths, clearly indicate that lot 2 received an exceptionally small amount of the fumigant, while lot 7 was subjected to a concentration greater than the average.

TABLE 1B. PER CENT KILL AS SHOWN BY EXAMINATIONS AT DIFFERENT INTERVALS AFTER FUMIGATION

Lot No.	Number insects used	Per cent kill after— 0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days
1	131	100	94.7	75.6	73.3	68.7	63.4	58.0	58.0	64.1	66.4	67.2	68.7	70.2	71.8	77.1
2	147	100	9.5	7.5	9.5	11.6	12.9	14.3	15.0	15.6	19.7	21.1	21.1	23.1	25.2	25.8
3	137	100	93.4	57.7	51.1	44.5	43.1	40.1	42.3	46.0	50.4	54.7	59.8	61.3	62.0	67.9
4	152	100	87.5	58.5	50.0	37.8	30.4	30.9	32.2	35.7	41.4	42.8	46.7	52.0	55.3	57.9
5	185	100	73.3	35.7	20.5	15.7	22.7	24.3	28.1	30.3	36.8	39.5	42.2	49.7	52.4	56.2
6	130	100	60.8	28.5	21.5	21.5	21.5	23.8	30.0	36.1	40.0	47.7	51.5	53.1	54.6	54.6
7	119	100	100.0	93.3	92.4	88.2	83.2	84.0	78.9	73.1	74.8	72.2	75.5	78.9	83.2	85.0
Total & Avg.	1001	100	73.2	49.2	43.2	38.7	37.6	37.5	39.0	41.4	45.7	48.0	50.9	54.4	56.6	59.6

Each disparity between revivals and subsequent deaths affects the percentage of calculated kill. Table 1B presents, in percentages, the resultant of the two trends recorded numerically in Table 1A. The average per cent of kill declines from 100% on the zero day to a minimum of 37.5% on the sixth day, then rises again to a final kill of 59.6% on the fourteenth day after fumigation. Were this curve plotted it would consist roughly of three portions. The sharp initial descent and the gradual terminal ascent would be separated by a comparatively horizontal interval from the fourth to the seventh day. This 4-day period represents a period of comparative inactivity or balanced activity between the two separate trends observed in Table 1A.

The importance of the interval between fumigation and examination is obvious. Had the final inspection been made 24 hours after fumigation the recorded kill would have been 35.7% higher than it was six days after treatment, and 13.6% greater than it was on the fourteenth day following fumigation.

Experiment II

Fumigation of	Railway car	Lading	25-lb. boxes bulk raisins, with glasine paper liners
Charge of CS_2	41.8£ 1000 c.f.		
Exposure	24 hrs, 30 min.	Temp. (Fahr.)	Start, 64; end, 68
Insects	(a) Oryzaephilus adults	P.c.Rel.Hum.	Start, 51; end, 51
	(b) Plodia larvae (grown)	Date	March 11–12, 1926

Table 2A. Record of Protracted Counts

(a) Oryzaephilus adults

Lot No.	Original count Condition	Original count 0 day	Nature of change	Subsequent changes — Number of individuals changing status after— 1 day	2 ds.	3 ds.	4 ds.	5 ds.	6 ds.	7 ds.	8 ds.	9 ds.	10 ds.	11 ds.	12 ds.	Totals	No. moths issued	Per cent emergence
1	Living	0	Deaths	0	0	2	3	2	3	6	9	19	20	8	5	77		
	Dead	142	Revivals	0	29	33	56	5	0	0	0	0	0	0	0	123		
2	Living	0	Deaths	0	0	5	10	1	4	8	8	20	10	8	8	82		
	Dead	151	Revivals	18	48	58	14	3	0	0	0	1	0	0	0	142		
3	Living	0	Deaths	0	0	2	0	4	5	4	3	5	3	3	1	30		
	Dead	139	Revivals	28	66	18	0	0	0	0	0	0	0	0	0	112		
4	Living	0	Deaths	0	0	0	3	8	7	10	11	12	12	14	5	77		
	Dead	110	Revivals	0	23	30	41	0	0	0	0	0	0	0	1	95		
5	Living	0	Deaths	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Dead	101	Revivals	0	0	0	0	0	0	0	0	0	0	0	0	0		
6	Living	0	Deaths	0	0	0	1	5	5	6	12	32	12	2	18	93		
	Dead	149	Revivals	6	8	35	64	3	0	0	0	3	1	0	0	120		
7	Living	0	Deaths	0	0	5	6	4	8	7	6	14	1	7	2	60		
	Dead	114	Revivals	10	17	34	27	3	0	0	0	0	0	0	1	92		
8	Living	0	Deaths	0	0	3	5	14	7	12	7	11	13	0	4	76		
	Dead	128	Revivals	7	20	39	30	2	0	0	0	2	0	0	0	100		
9	Living	0	Deaths	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Dead	95	Revivals	0	0	0	0	0	0	0	0	0	0	0	0	0		
Tot.	Living	0	Deaths	0	0	17	28	33	39	53	56	113	71	42	43	495		
& Av.	Dead	1129	Revivals	69	211	247	232	16	0	0	0	6	1	0	2	784		

(b) Plodia larvae

Lot No.	Condition	0 day	Nature of change	Number of individuals changing status after— 1 d.	2 d.	3 d.	4 d.	5 d.	6 d.	7 d.	8 d.	9 d.	10 d.	11 d.	12 d.	16 d.	17 d.	18 d.	20 d.	21 d.	24 d.	25 d.	Totals	No. moths issued	Per cent emergence
1	Living	0	Deaths	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Dead	7	Revivals	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2	2	100
2	Living	0	Deaths	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	3		
	Dead	7	Revivals	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	4	1	25
3	Living	0	Deaths	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1		
	Dead	7	Revivals	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	75
4	Living	0	Deaths	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1		
	Dead	6	Revivals	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2	0	1
5	Living	0	Deaths	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Dead	9	Revivals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	—
6	Living	0	Deaths	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1		
	Dead	10	Revivals	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2	1	50
7	Living	0	Deaths	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2		
	Dead	6	Revivals	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	8	1	33
8	Living	0	Deaths	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1		
	Dead	10	Revivals	0	0	0	0	0	1	0	1	0	3	0	0	0	0	0	0	0	0	0	5	0	0
9	Living	0	Deaths	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1		
	Dead	10	Revivals	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Tot.	Living	0	Deaths	0	0	0	0	0	0	0	0	0	0	1	0	0	3	1	3	0	1	1	10		
& Av.	Dead	72	Revivals	0	0	0	1	2	5	0	2	5	3	3	2	0	0	0	0	0	0	0	23	8	35

TABLE 2B. PER CENT KILL AS SHOWN BY EXAMINATIONS AT DIFFERENT INTERVALS AFTER FUMIGATION

(a) Oryzaephilus adults (b) Plodia larvae

Insect	Lot No.	No. insects used	Per cent kill after— 0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	15 days	17 days	18 days	20 days	21 days	24 days	25 days
	1	142	100.0	100.0	79.6	57.7	20.4	18.3	20.4	24.6	31.0	44.3	58.4	64.0	67.6							
	2	151	100.0	88.1	56.3	21.2	18.5	17.2	19.9	25.2	30.5	43.0	49.7	55.0	60.3							
	3	139	100.0	79.9	32.4	20.9	20.9	23.7	27.3	30.2	32.4	36.0	38.1	40.3	41.0							
	4	110	100.0	100.0	79.1	51.8	17.3	20.0	26.4	35.5	45.5	51.8	62.7	75.5	79.1							
(a)	5	101	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0							
	6	149	100.0	96.0	90.6	67.1	24.8	26.2	29.5	33.6	41.6	61.1	68.5	69.8	81.9							
	7	114	100.0	91.2	76.3	50.1	32.5	33.3	40.4	46.5	51.8	64.0	64.9	71.1	71.9							
	8	128	100.0	94.5	78.9	50.8	31.3	40.6	46.1	55.5	60.9	68.0	78.1	78.1	81.3							
	9	95	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0							
Tot. & Avg.		1129	100.0	93.9	75.2	54.8	36.8	38.3	41.7	46.4	51.4	60.4	66.6	70.3	74.0							
	1	7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	85.7	85.7	71.4	71.4	71.4	71.4	71.4	71.4	71.4	71.4	71.4
	2	7	100.0	100.0	100.0	100.0	100.0	100.0	71.4	71.4	71.4	42.8	42.8	57.1	57.1	57.1	71.4	85.7	85.7	85.7	85.7	85.7
	3	7	100.0	100.0	100.0	100.0	85.7	57.1	42.8	42.8	42.8	42.8	42.8	42.8	42.8	42.8	42.8	42.8	57.1	57.1	57.1	57.1
	4	6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	83.3	83.3	66.7	66.7	66.7	83.3	83.3	83.3	83.3	83.3	83.3
(b)	5	9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	6	10	100.0	100.0	100.0	100.0	100.0	100.0	90.0	90.0	90.0	90.0	90.0	90.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
	7	6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	83.3	83.3	83.3	66.7	50.0	50.0	66.7	66.7	66.7	66.7	83.3	83.3
	8	10	100.0	100.0	100.0	100.0	100.0	100.0	90.0	90.0	80.0	80.0	50.0	50.0	50.0	50.0	50.0	60.0	60.0	60.0	60.0	60.0
	9	10	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	100.0	100.0	100.0	100.0
Tot. & Avg.		72	100.0	100.0	100.0	100.0	98.6	95.8	88.9	88.9	86.1	79.2	75.0	72.2	69.4	69.4	73.6	75.0	79.2	79.2	80.6	81.9

The protracted count of Oryzaephilus adults presented in Table 2A roughly parallels the general trend of the preceding experiment, but the average level of kill is here higher, this being due to the presence of two lots showing perfect kills throughout the period of observation. With the exception of these two lots, revivals outnumbered subsequent deaths in each instance; in the totals, revivals exceeded the subsequent deaths by more than half. Thus, as shown in Table 2B, for Oryzaephilus we have an average kill of 100% on the zero day ranging downward to 36.8% on the fourth day, and attaining 74% on the twelfth day. It is also noteworthy that the recorded kill twenty-four hours after treatment exceeded that determined four and twelve days after fumigation by approximately 57% and 20%, respectively.

With regard to Plodia larvae, reference to the numerical record of changes in Table 12A establishes the limits of revival as the fourth and twelfth days, with the maximum revival occurring from the eighth to the twelfth day. Lots 3 and 5 present the principal departures from the average trend, inasmuch as the revivals in the former were exceptionally early, while in the latter there were no revivals. Table 2B shows for Plodia 100% kill through the third day, diminishing to 69.4% which obtained from the twelfth to the fifteenth day, and gradually increasing to 81.9% on the twenty-fifth day. With this species we see that the kill recorded twenty-four hours after fumigation was approximately 30% greater than that obtaining from twelve to fifteen days after fumigation, and was some 18% in excess of the kill shown twenty-five days after treatment. It should also be noted that, by the method of Neifert and Garrison above quoted, a perfect average kill of these larvae would have been determined, showing that constancy of the percentage of dead for two successive days is not a reliable criterion for this species when fumigated with carbon disulphid.

Revived larvae were, in this experiment, retained to determine whether any of them would develop to the imaginal condition. The data at the extreme right in Table 2A show that of 23 revivals, 13 survived on the twenty-fifth day, and that 8 of these individuals subsequently issued as adults. Thus 35% of the total revivals, or 62% of those alive 25 days after fumigation, produced moths.

The most remarkable disclosure of this examination is the length of time after which some larvae revived. Lots 1, 4, and 9, for instance, showed no revivals until the ninth day after fumigation. Both of the revivals from lot 1 produced adults, but none issued from lots 4 and 9. Indeed, taking the experiment as a whole, approximately two-thirds of the revivals occurred more than a week after fumigation.

Bearing in mind the fact that similarly numbered lots of Oryzaephilus adults and Plodia larvae were situated side by side during the fumigation, it is most interesting to note the difference in the revival phenomena of the two species. The lowest levels of average kill obtain on the fourth to fifth day and the twelfth to fifteenth day, respectively, for Oryzaephilus and Plodia. Despite the different reactions of the two species, a comparison of analagous lots reveals certain similarities. For instance, lots 5 and 9 of Plodia present close approximations to similarly numbered lots of Oryzaephilus showing perfect kills, for, although one larva revived in lot 9, it succumbed before the end of the detailed examination. Again, lot 3 is, in both cases, characterized by exceptionally early revival and by the lowest percentage of kill in the experiment. Further, lots 1 and 4 of Oryzaephilus began reviving one day later than all others which showed revival; similarly, the first revivals of lots 1 and 4 of Plodia occurred at the maximum revival interval shown in this experiment.

Unfortunately, the protracted count of Experiment III was terminated prematurely by oversight, and the record extends only to the fifth day after fumigation. The results are presented because of a variation in the method here introduced. In order to ascertain the effect

EXPERIMENT III[6]

Fumigation of	Railway car	Lading	25-lb. boxes bulk raisins, with glasine paper liners
Charge of CS_2	14.9£ 1000 c.f.		
Exposure	21 hrs., 30 min.	Temp. (Fahr.)	Start, 97; end, 88
Insect	Oryzaephilus adults	P.c.Rel.Hum.	Start, 60; end, 62
		Date	April 13–14, 1926

TABLE 3. PER CENT KILL AS SHOWN BY EXAMINATIONS AT DIFFERENT INTERVALS AFTER FUMIGATION

Lot No.	No. insects used	Per cent kill after— 0 day	1 day	2 days	3 days	4 days	5 days
1	139	100	8.6	28.8	33.8	40.3	43.2
2	109	100	15.6	35.8	37.6	42.2	43.1
3	119	100	84.3	83.8	83.8	82.0	85.6
4	128	100	22.7	43.8	44.5	47.7	50.8
5	103	100	100.0	100.0	100.0	100.0	100.0
6	93	100	24.7	50.5	52.7	52.7	58.1
Total & Avg.	691	100	41.1	54.7	56.4	58.8	61.4
7	114	[1]		100.0	93.0	93.0	95.6
8	70	[1]		44.3	51.4	52.9	52.9
9	150	[1]		100.0	92.0	92.7	91.3
Total & Avg.	334	[1]		88.3	83.8	84.4	84.7

[1]Test-lot not removed from boxes of raisins until the second day after fumigation.

[6]By way of shortening this paper, the remaining results are shown only in terms of per cent kill, this, as above noted, representing the resultant of the two trends of revival and subsequent death.

upon revival of leaving the test lots longer in the boxes of fumigated fruit, three of these were not removed until the second day after fumigation.

The average of the first part of this experiment shows the maximum revival to have occurred on the first day following fumigation, with a steady increase in the percentage of mortality thereafter. The average of the second portion also shows the maximum revival on the next day after removal of the lots from the fumigated boxes of fruit; that is, on the third day after fumigation. Despite the fact that the level of kill is higher in the portion remaining longer in the boxes, no conclusion as to the effect of the delayed removal upon mortality is warranted in view of the fact that in Experiment 2, where the corresponding lot numbers represent similar locations in both experiments, the average of the last three lots is likewise higher than that of the remainder.

EXPERIMENT IV

Fumigation of	Railway car	Lading	Boxes packed with 3 dozen 15-oz. cartons each; cartons without paper liners.
Charge of CS_2	10.94£ 1000 c.f.		
CO_2	5.06£ 1000 c.f.	Temp. (Fahr.)	Start, 92; end, 118
Exposure	6 hrs., 5 min.	P.c.Rel.Hum.	Start, 25; end, 9[1]
Insect	Oryzaephilus adults	Date	August 5, 1925

TABLE 4. PER CENT KILL AS SHOWN BY EXAMINATIONS AT DIFFERENT INTERVALS AFTER FUMIGATION

Lot No.	No. insects used	Per cent kill after — 1 day	3 days	5 days	7 days	10 days
1	110	82.7	87.3	90.0	94.5	97.3
2	191	14.1	55.0	57.1	62.3	63.3
3	204	99.5	97.1	97.1	97.1	98.5
4	185	100.0	100.0	100.0	100.0	100.0
Total & Avg.	690	73.3	84.6	85.7	87.8	89.0

[1]Rel. Hum. percentages taken from Weather Bureau Office records for noon and 5:00 p. m., respectively.

Experiment 4, in contrast to the preceding ones, presents a constant upward trend of the average kill from the first to the tenth day after fumigation. A total of ten revivals occurred, all by the third day; two of the revived beetles in lot 3 survived beyond the tenth day.

Experiment V

Fumigation of	Railway car	Lading	Boxes packed with 3 dozen 15-oz. cartons each; cartons without paper liners.
Charge of CS_2	19.23£ 1000 c.f.		
CO_2	5.09£ 1000 c.f.	Temp. (Fahr.)	Start, 92; end, 118
Exposure	5 hrs., 45 min.	P.c.Rel.Hum.	Start, 25; end, 9[1]
Insect	Oryzaephilus adults	Date	August 5, 1925

Table 5. Per Cent Kill as Shown by Examinations at Different Intervals After Fumigation

Lot No.	No. insects used	Per cent kill after— 1 day	3 days	5 days	7 days	10 days
1	172	3.5	12.3	14.0	15.1	17.4
2	209	100.0	100.0	100.0	100.0	100.0
3	195	4.8	18.2	19.1	20.1	21.1
4	183	100.0	100.0	100.0	100.0	100.0
Total & Avg.	759	51.9	57.6	58.2	58.8	59.6

[1]Rel. Hum. percentages taken from Weather Bureau Office records for noon and 5:00 p. m., respectively.

Table 5 shows all subsequent changes to have occurred in lots 1 and 2, where the very small original kills gradually increased to approximately 20% on the tenth day. Only 1 revival was recorded.

Experiment VI

Fumigation of	Railway car, papered interiorly	Lading	25-lb. boxes bulk raisins, with glasine paper liners
Charge of CS_2	30.4£ 1000 c.f.	Temp. (Fahr.)	Start, 88; end, 79
Exposure	18 hrs., 30 min.	P.c.Rel.Hum.	Start, 42; end, 40
Insect	Oryzaephilus adults	Date	June 11–12, 1926

Table 6. Per Cent Kill as Shown by Examinations at Different Intervals After Fumigation

Lot No.	No. insects used	Per cent kill after— 0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days
1	146	100	100	100	100	100	100	100	100	100	100
2	138	100	100	100	100	100	100	100	100	100	100
3	112	100	100	100	100	100	100	100	100	100	100
4	111	100	100	100	100	100	100	100	100	100	100
5	82	100	100	100	100	100	100	100	100	100	100
6	106	100	100	100	100	100	100	100	100	100	100
Tot. & Avg.	695	100	100	100	100	100	100	100	100	100	100
7	126	[1]		100	100	100	100	100	100	100	100
8	116	[1]		100	100	100	100	100	100	100	100
9	115	[1]		100	100	100	100	100	100	100	100
Tot. & Avg.	357	[1]		100	100	100	100	100	100	100	100

[1]Test-lot not removed from box of raisins until second day after fumigation.

Table 6 shows a perfect kill with no revivals. Since this applies both to the lots removed from fumigated boxes at the end of the exposure as well as to those removed therefrom two days later, the im-

EXPERIMENT VII

Fumigation of	Sulphur House (Brick and Cement)	Lading	25-lb. boxes bulk raisins, with glasine paper liners
Charge of CS_2	22.9£ 1000 c.f.		
Exposure	25 hrs.	Temp. (Fahr.)	Start, 63; end, 63
Insects	(a) Oryzaephilus adults	P.c.Rel.Hum.	Start, 51; end, 51
	(b) Plodia larvae (grown)	Date	March 11–12, 1926

TABLE 7. PER CENT KILL AS SHOWN BY EXAMINATIONS AT DIFFERENT INTERVALS AFTER FUMIGATION

Insect	Lot No.	No. insects used	Per cent kill after— 0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	15 days	17 days	18 days	20 days	21 days	24 days	25 days
	1	142	100.0	13.4	2.8	4.2	6.3	7.0	7.7	8.5	9.9	11.3	12.0	14.8	14.8							
(a)	2	135	100.0	92.6	80.0	55.5	47.4	43.7	48.9	55.5	61.5	71.9	83.0	92.6	95.1							
	3	117	100.0	94.0	64.1	56.4	23.9	27.4	28.2	31.6	37.6	44.4	48.7	48.7	50.4							
Tot. & Avg.		394	100.0	64.5	47.5	37.3	25.6	25.6	27.9	31.5	35.8	41.9	47.2	51.5	53.3							
	1	5	100.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
(b)	2	10	100.0	100.0	100.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	50.0	30.0	30.0	30.0	30.0	30.0	40.0	40.0
	3	9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	78.0	78.0	78.0	67.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Tot. & Avg.		24	100.0	87.0	87.0	71.0	67.0	71.0	71.0	71.0	62.0	62.0	62.0	58.0	46.0	37.0	37.0	37.0	37.0	37.0	42.0	42.0

portance of the time of removal of the lots from fumigated packages appears to be slight.

B. SULPHUR-HOUSE FUMIGATION

Only one experiment attaches to this category. The results, as embodied in Table 7, present a general coincidence with the results of Experiment 2, as shown in Table 2B. Both experiments were made on the same dates. The correspondingly numbered lots of the two species used in this experiment were fumigated side by side.

Here, again, we find revival and subsequent death operating to establish varying percentages of mortality throughout the protracted examination. In the case of the Oryzaephilus average, revival depresses the initial perfect kill to a minimum of 25.6% on the fourth day; during the succeeding eight days subsequent death elevates the kill to 53.3% on the twelfth day. Thus, the kill revealed one day after treatment was approximately 39% greater than that determined on the fourth (or fifth) day, and also exceeded the percentage of dead recorded twelve days after fumigation by approximately 11%.

With Plodia revival was slower; the original average kill of 100% diminished to 37% from the fifteenth to the twenty-first day, and reached 42% twenty-five days after fumigation. In this case the effectiveness determined one day after treatment exceeded by 50% and 45%, respectively, the percentages of dead which obtained fifteen (to twenty-one) and twenty-five days after fumigation. It is also clear that, by the method of selecting the percentage of dead which was constant for two successive days, perfect kills would have been recorded for lots 2 and 3, whereas the percentages of dead after twenty-five days were 40% and 44%, respectively.

The revival of the Plodia lots is most interesting. It will be observed that the earliness of revival varied greatly in the three lots. The total revivals in lot 1 occurred on the first day; in lot 2 the first revivals occurred on the third day, with others reviving between the twelfth and the fifteenth day; finally, in lot 3, revival began on the eighth day and was again operative on the eleventh and the twelfth day. Lots 1, 2, and 3 were located at the top, middle, and bottom, respectively, of the sulphur-house. It thus appears that the carbon disulphid gas, in the absence of agitation assumed a greater density toward the bottom and that this density is directly correlated with the tardiness of revival. However, little effect upon the extent of revival is attributable to such a stratification of the fumigant. Moreover, the survival after

Experiment VIII

Fumigation of	Trash Fumigator	Lading	25-lb. boxes bulk raisins, with glasine paper liners
Charge of CS_2	21.8 £ 1000 c.f.		
Exposure	24 hrs.	Temp. (Fahr.)	Start, 58; end, 60
Insects	(a) Oryzaephilus adults	P.c.Rel.Hum.	Start, 69; end, 83[1]
	(b) Plodia larvae (grown)	Date	February 3–4, 1926

Table 8. Average Per Cent Kill as Shown by Examinations at Different Intervals After Fumigation

Insect	No. of test-lots used	No. insects used	Per cent kill after— 0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	15 days	16 days	17 days	18 days
(a)	3	146	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
(b)	3	29	100.0	100.0	100.0	100.0	100.0	100 0	100 0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1]Rel. Hum. percentages taken from Weather Bureau records for the noon periods of the two days.

twenty-five days gives no indication that it is influenced by the time of revival.

C. FUMIGATION IN TRASH FUMIGATOR

One experiment was performed in this type of chamber. The interior lining of felt roofing minimized the leakage factor. Evaporation of the carbon disulphid was promoted by saturating gunny sacks with it and suspending them from the top of the chamber. The kill of both Oryzaephilus and Plodia was perfect and there were no revivals, as shown in Table 8.

D. PACKING-PLANT FUMIGATION

The percentages of kill of Oryzaephilus and Plodia in Experiment 9, as set down in Table 9, again reflect the prolonged influence of revival and subsequent death.

Two of the Oryzaephilus lots show perfect kills throughout the period of examination. From lot 5, one beetle, which revived by the third day, survived on the twenty-first day. In lots 2, 3, and 4 sharp reductions in the percentages of apparent mortality occurred during the first three days, while counts on the fifth day and subsequent thereto showed gradual increases in the percentages of dead. With respect to these three lots it is noteworthy that the percentage of dead on the final day in no case attained the initial figure, but represented points intermediate between the counts of the zero and the third day. Thus it is certain that approximately one-third of the revived beetles still survived three weeks after fumigation.

This is the only experiment in which the Oryzaephilus counts were extended over three weeks, and it is interesting to note the trivial nature of the changes which occurred during the third week.

No Plodia larvae revived during the first week after fumigation, and the greatest number of revivals was recorded on the ninth and the eleventh day. Thus, constancy of the percentage of dead for two, or even seven, successive days would not have provided an accurate indication of effectiveness. The maximum revival had been attained by the fifteenth day, when the average kill was 61.6%. Thereafter, subsequent deaths operated to establish a kill of 69.6% on the twenty-fifth day after fumigation.

This experiment permits no comparison of the 24-hour method with protracted examination since no count was made on the first day after fumigation.

In this experiment the examination of Plodia revivals extended

Experiment IX

Fumigation of	Packing Plant	Contents	Stored figs in stacked picking boxes
Charge of CS_2	2.9 £ 1000 c.f.	Temp. (Fahr.)	Start, 73; end —
Exposure	36 hrs.	P.c.Rel.Hum.	Start, 37; end —
Insects	(a) Oryzaephilus adults (b) Plodia larvae (grown)	Date	October 10–12, 1925

Table 9. Per Cent Kill as Shown by Examinations at Different Intervals After Fumigation

Insect	Lot No.	No. insects used	Per cent kill after— 0 days	3 days	5 days	7 days	9 days	11 days	13 days	15 days	17 days	19 days	21 days	23 days	25 days	95 days	130 days	144 days	156 days	173 days
	1	126	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0							
	2	117	88.9	62.4	75.2	77.8	79.5	81.2	82.1	82.1	82.1	82.1	82.1							
(a)	3	85	91.8	51.8	63.5	75.3	77.6	77.6	80.0	80.0	83.5	83.5	83.5							
	4	104	94.2	73.1	74.0	79.8	79.8	81.7	81.7	81.7	81.7	81.7	81.7							
	5	97	100.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0							
	6	108	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0							
Tot. & Avg.		637	95.9	82.1	86.2	89.2	89.8	90.4	90.9	90.9	91.4	91.4	91.4							
	1	25	100.0	100.0	100.0	100.0	100.0	100.0	96.0	68.0	72.0	84.0	88.0	88.0	88.0	88.0	92.0	96.0	100.0	—
	2	25	100.0	100.0	100.0	100.0	100.0	84.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	64.0	64.0	68.0	84.0	100.0
(b)	3	25	100.0	100.0	100.0	100.0	60.0	56.0	56.0	56.0	56.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	84.0	[1]
	4	25	100.0	100.0	100.0	100.0	64.0	56.0	60.0	60.0	60.0	64.0	64.0	64.0	64.0	68.0	72.0	80.0	100.0	—
	5	25	100.0	100.0	100.0	100.0	100.0	68.0	72.0	72.0	72.0	80.0	80.0	80.0	80.0	92.0	96.0	100.0	—	—
Tot. & Avg.		125	100.0	100.0	100.0	100.0	84.3	72.8	68.0	61.6	63.2	68.8	69.6	69.6	69.6	74.4	76.8	80.8	93.6	96.8

[1]This container was discarded by mistake.

approximately five months beyond the usual twenty-five day period. Although comparatively few of the larvae died during the first four months of this additional period, practically all succumbed during the fifth month. These larvae fed little and, while most of them died as larvae, several pupated successfully. It is noteworthy that all of these apparently normal pupae gradually became shriveled and discolored, and none of them produced adults. The loss of the container with the four larvae which survived 173 days after fumigation is most unfortunate, although it seems probable that they too would have died. These results are very different from those of Experiment 2 where some revived larvae later issued as adults. The writers are inclined to attribute this difference to the fact that that experiment was conducted in the spring while this one was performed in the fall. Thus the larvae, after revival in this experiment, were subject to a prolonged period of unfavorable weather while those of Experiment 2 were soon subject to conditions suitable for their further development.

This experiment, in common with number 7, provides no indication of a correlation between the time of revival and the proportion of survival. Thus, in the lots (3 and 4) showing the earliest revivals, being on the ninth day, approximately one-third of the revivals subsequently died. From lots 1 and 5, which started reviving on the thirteenth and eleventh day, respectively, approximately two-thirds of the revivals died. However, in lot 2 the revivals were also delayed until the eleventh day, but here only one-ninth of them had died by the twenty-fifth day.

EXPERIMENT X

Fumigation of	Packing Plant	Contents	Stored figs in stacked picking boxes
Charge of CS_2	2.76£ 1000 c.f.		
Exposure	25 hrs., 15 min.	Temp. (Fahr.)	Start, 83; end, 88
Insects	(a) Oryzaephilus adults	P.c.Rel.Hum.	Start, 29; end, 37
	(b) Plodia larvae (grown)	Date	June 27–28, 1926.

TABLE 10. AVERAGE PER CENT KILL AS SHOWN BY EXAMINATIONS AT DIFFERENT INTERVALS AFTER FUMIGATION

Insect	No. of test-lots used	No. insects used	Per cent kill after— 0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	10 days
(a)	6	686	100	100	100	100	100	100	100	100	100	100	100
(b)	6	90	100	100	100	100	100	100	100	100	100	100	100

Tables 10 and 11 show the average percentages of kill of both Oryzaephilus and Plodia to have been perfect. There were no revivals. The Plodia larvae were not checked longer than ten days because of

EXPERIMENT XI

Fumigation of	Packing Plant	Contents	Stored figs in stacked picking boxes
Charge of CS^2	2.47£ 1000 c.f.		
Exposure	25 hrs., 15 min.	Temp. (Fahr.)	Start, 85; end, 88
Insects	(a) Oryzaephilus adults	P.c.Rel.Hum.	Start, 44; end, 37
	(b) Plodia larvae (grown)	Date	June 27–28, 1926

TABLE 11. AVERAGE PER CENT KILL AS SHOWN BY EXAMINATIONS AT DIFFERENT INTERVALS AFTER FUMIGATION

Insect	No. of test-lots used	No. insects used	Per cent kill after— 0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	10 days
(a)	6	717	100	100	100	100	100	100	100	100	100	100	100
(b)	6	90	100	100	100	100	100	100	100	100	100	100	100

their brown color and dried, shriveled condition, indicating certain death.

Table 12, presenting the results of this experiment, shows that no revivals occurred. Three lots yielded perfect kills throughout the examination. The other three showed gradual increases in mortality to the seventh day; thereafter no changes occurred.

Three revivals occurred in this experiment, but, as shown in Table 13, the results otherwise closely parallel those of the preceding experiment.

Table 14 shows that the kill in this experiment, even as determined on the zero day, was considerably short of 100%. It is noteworthy that here, with the exception of lot 6, the revival occurred early, establishing the average percentage of minimum kill on the sixth day, whereas in other experiments presented above the major revival did not occur until after the first week. This earliness of revival indicates a very imperfect fumigation, and this is further supported by the great extent to which revival proceeded. Attention is directed to the decline of the average percentage of effectiveness from 64.8% on the zero day to 26.9% on the sixth day, and the subsequent increase to 31.9% on the twenty-fifth day. By the thirty-fifth day the mortality had increased to 43.1%. Thus, by a final count made one day after fumigation the average effectiveness would have exceeded by approximately 34% and 18%, respectively, the mortality determined six and thirty-five days after fumigation.

The results of this experiment, embodied in Table 15, are rather similar to those of the preceding experiment. In two lots complete revival obtained for a time. The percentage of average kill on the zero day was 85.8%; on the sixth day, 22.3%; on the twenty-fifth day, 35.2%; and on the thirty-fifth day, 38.6%. Thus, the percentage of kill re-

Experiment XII

Fumigation of	Packing Plant	Contents	Stored figs in stacked picking boxes
Charge of CS_2	2.76£ 1000 c.f.	Temp. (Fahr.)	Start, 92; end, 71
Exposure	37 hrs., 30 min.	P.c.Rel.Hum.	Start, 32; end, 23
Insect	Oryzaephilus adults	Date	August 14–16, 1926

Table 12. Per Cent Kill as Shown by Examinations at Different Intervals After Fumigation

Lot No.	No. insects used	Per cent kill after—												
		0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days
1	42	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2	40	100.0	100.0	100.0	100.0	100 0	100 0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3	33	78.8	81.8	81.8	87.9	87 9	93.9	93 9	97.0	97.0	97.0	97.0	97.0	97.0
4	36	86.1	86.1	88.9	88.9	94.4	97.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0
5	53	71.7	75.5	75.5	75 5	84.9	92.5	92.5	96.2	96.2	96.2	96.2	96.2	96.2
6	46	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Tot. & Avg.	250	89.2	90.4	90.8	91.6	94.4	97.2	97.6	98.8	98.8	98.8	98.8	98.8	98.8

Experiment XIII

Fumigation of	Packing Plant	Contents	Stored figs in stacked picking boxes
Charge of CS_2	2.47 £ 1000 c.f.	Temp. (Fahr.)	Start, 89; end, 73
Exposure	37 hrs., 30 min.	P.c.Rel.Hum.	Start, 36; end, 42
Insect	Oryzaephilus adults	Date	August 14–16, 1926

Table 13. Per Cent Kill as Shown by Examinations at Different Intervals After Fumigation

Lot No.	No. insects used	Per cent kill after— 0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days
1	43	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2	54	96.3	92.6	92.6	94.4	96.3	96.3	96.3	96.3	96.3	98.1	98.1	98.1	98.1
3	40	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
4	51	78.4	76.5	88.2	92.2	92.2	96.1	98.0	100.0	100.0	100.0	100.0	100.0	100.0
5	32	88.4	84.4	87.5	96.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
6	52	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Tot. & Avg.	272	93.4	92.3	94.9	97.1	97.8	98.5	98.9	99.3	99.3	96.6	99.6	99.6	99.6

Experiment XIV

Fumigation of	Packing Plant	Contents	Stored figs in stacked picking boxes
Charge of CS_2	2.47 £ 1000 c.f.	Temp. (Fahr.)	Start, 65; end, 54
Exposure	39 hrs., 45 min.	P.c.Rel.Hum.	Start, 48; end, 53
Insect	Plodia larvae (grown)	Date	November 6–8, 1926

Table 14. Per Cent Kill as Shown by Examinations at Different Intervals After Fumigation

Lot No.	No. insects used	Per cent kill after— 0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	15 days	17 days	19 days	21 days	25 days	35 days
1	25	96.0	96.0	72.0	24.0	28.0	28.0	28.0	28.0	24.0	24.0	24.0	28.0	24.0	24.0	24.0	24.0	24.0	28.0	32.0	32.0	44.0
2	25	24.0	24.0	16.0	12.0	8.0	8.0	8.0	8.3	8.3	8.3	8.3	8.3	8.3	8.3	20.8	20.8	20.8	20.8	20.8	20.8	33.3
3	25	28.0	8.0	8.0	4.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	16.0
4	25	76.0	76.0	44.0	20.0	16.0	16.0	12.0	12.0	16.0	20.0	20.0	20.0	20.0	20.0	20.0	16.0	16.0	16.0	16.0	16.0	36.0
5	25	72.0	72.0	48.0	20.0	32.0	36.0	20.0	32.0	28.0	28.0	24.0	24.0	24.0	24.0	28.0	28.0	28.0	28.0	28.0	28.0	40.0
6	20[1]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	95.0	95.0	90.0	90.0	90.0	90.0	90.0	100.0	100.0	100.0	100.0
Tot & Avg.	145	64.8	61.4	46.2	27.6	29.7	30.3	26.9	29.2	28.5	29.2	27.8	28.5	27.1	27.1	29.9	29.2	29.2	31.3	31.9	31.9	43.1

[1]Five larvae were here found mashed and have been deducted. Note: Lot 2, 7th day, 1 larva mashed; deducted.

EXPERIMENT XV

Fumigation of	Packing Plant	Contents	Stored figs in stacked picking boxes
Charge of CS_2	3.18 £ 1000 c.f.	Temp. (Fahr.)	Start, 64; end, 54
Exposure	39 hrs., 45 min.	P.c.Rel.Hum.	Start, 51; end, 53
Insect	Plodia larvae (grown)	Date	November 6–8, 1926

TABLE 15. PER CENT KILL AS SHOWN BY EXAMINATIONS AT DIFFERENT INTERVALS AFTER FUMIGATION

Lot No.	No. insects used	Per cent kill after— 0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	15 days	17 days	19 days	21 days	25 days	35 days
1	25	100.0	100.0	76.0	56.0	44.0	28.0	28.0	32.0	28.0	36.0	32.0	32.0	28.0	28.0	28.0	28.0.	29.0	33.0	33.0	37.5	41.7
2	25	72.0	52.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	4.0	8.0	8.0	8.0	8.0	8.0	8.0	12.0
3	25	100.0	88.0	20.0	0.0	0.0	0.0	0.0	0.0	8.0	12.0	12.0	12.0	12.0	16.0	16.0	16.0	16.0	24.0	24.0	24.0	28.0
4	25	64.0	48.0	32.0	28.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	40.0	44.0	44.0	44.0	48.0
5	25	80.0	44.0	20.0	12.0	16.0	20.0	20.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	28.0	28.0	32.0	32.0	36.0	36.0
6	23	100.0	91.0	83.0	74.0	70.0	65.0	52.0	61.0	61.0	57.0	57.0	57.0	57.0	57.0	57.0	62.0	67.0	67.0	67.0	67.0	67.0
Tot. & Avg.	148	85.8	70.3	38.5	27.7	27.0	24.3	22.3	25.0	25.7	27.0	26.4	26.4	26.0	26.7	27.4	28.8	30.3	33.8	33.8	35.2	38.6

Note: Lot 1, 17th day, 1 living larva crushed. Deducted from count. Lot 6, 12th day, 2 living larvae escaped. Deducted from count.

vealed one day after treatment was 48% greater than that observed six days after fumigation. Furthermore, five weeks after fumigation there were approximately 32% more larvae alive than appeared to be so one day after treatment.

Discussion

The Influence of Temperature on Revival

Mention by recent writers of the important influence of temperature on the effectiveness of carbon disulphid fumigation is well-nigh universal. Both Dean (*1*) and Hinds (*3*), in different ways, have emphasized this point. Both of these writers indicate that, in practical work, operations at temperatures below 60°F. are unsatisfactory. Girault (*2*), on the other hand, reported effective use of carbon disulphid at all temperatures, and stressed the point that failures in practical work are mostly attributable to serious loss of the vapor by leakage. None of these investigators referred to revival of treated insects, nor indicated the interval between fumigation and final examination of the insects as employed in experimental work.

While our immediate concern relates to revival and the length of time between treatment and examination, the bearing of the present data upon the temperature and leakage factors as above cited is of incidental interest.

The revival of Oryzaephilus and Plodia is a manifestation of imperfect fumigation wherein, however, the surviving individuals are, for a greater or lesser period, indistinguishable from the dead. That this reaction is definitely associated with moderately low temperatures is clearly shown by Table 16. Here the totals and averages of the preceding experiments pertaining to each species have been divided into two groups on the basis of the maximum temperature of fumigation. With each species the first group consists of experiments conducted under outside temperature maxima of 78°F. or lower; the second group, 81°F. or above.

The arrangement in Table 16 shows a striking contrast between the two divisions of each species, revealed both by the number of subsequent changes and by the average per cent kill at selected intervals. In the case of Oryzaephilus, with the exception of experiments in which perfect kills obtained throughout, the group influenced by the lower temperatures shows a constant excess of revivals over subsequent deaths; combining all experiments, the totals are approximately in the ratio of two to one. Excepting Experiment III, which may not properly be

TABLE 16. TOTALS AND AVERAGES OF EXPERIMENTS GROUPED ACCORDING TO TEMPERATURE: SHOWING RATIO OF REVIVALS TO SUBSEQUENT DEATHS AND THE COMPARATIVE TRENDS OF AVERAGE PERCENTAGES OF KILL OF (a) ORYZAEPHILUS ADULTS (b) PLODIA LARVAE (GROWN)

Expt. No.	Charge of CS. per 1000 c. f.	Exposure hrs.	Exposure min.	Temp. (Fahr.) Inside chamber At start	Temp. (Fahr.) Inside chamber At end	Temp. (Fahr.) Outside Max.	Per cent Rel. Hum At start	Per cent Rel. Hum At end	No. of insects used	Number of subsequent changes Revivals	Number of subsequent changes Sub. deaths	Early examination Days	Early examination % kill	1st intermediate examination Days	1st intermediate examination % kill	2nd intermediate examination Days	2nd intermediate examination % kill	Final examination Days	Final examination % kill
(a) Oryzaephilus adults																			
1	27.9	17	45	65	49	69	66	86	1001	796	391	1	73.2	5	37.6			14	59.6
2	41.8	24	30	64	68	70	51	51	1129	784	495	1	93.9	5	38.3			12	74.0
7	22.9	25	00	63	63	63[1]	51	51	394	329	145	1	64.5	5	25.6			12	53.3
8	21.8	24	00	58	60	60	69	83	146	0	0	1	100.0	5	100.0			14	100.0
9	2.9	36	00	73	—	75	37	—	637	96	67	0	95.9	5	86.2			15	90.9
3	14.9	21	30	77	76	81	60	62	691	475	215	1	41.1	5	61.4				
4	10.94	6	05	92	118	104	25	9	690	10	118	1	73.3	5	85.7			10	89.0
5	19.23	6	45	92	118	104	25	9	759	1	59	1	51.9	5	58.2			10	59.6
6	30.4	18	30	88	79	96	42	40	695	0	0	1	100.0	5	100.0			9	100.0
10	2.76	25	15	83	88	107	29	37	686	0	0	1	100.0	5	100.0			10	100.0
11	2.47	25	15	85	88	107	44	37	717	0	0	1	100.0	5	100.0			10	100.0
12	2.76	37	30	92	71	103	32	23	250	0	24	1	90.4	5	97.2			12	98.8
13	2.47	37	30	89	73	103	36	42	272	3	20	1	92.3	5	98.5			12	99.6
(b) Plodia larvae																			
2	41.8	24	30	64	68	70	51	51	72	23	10	1	100.0	7	88.9	15	69.4	25	81.9
7	22.9	25	00	63	63	63[1]	51	51	24	16	2	1	87.0	7	71.0	15	37.0	25	42.0
8	21.8	24	00	58	60	60	69	83	29	0	0	1	100.0	7	100.0	12	100.0	18	100.0
9	2.9	36	00	73	—	75	37	—	125	63	25	0	100.0	7	100.0	15	61.6	25	69.6
14	2.47	39	45	65	54	78	48	53	145	67	19	1	61.4	7	29.2	15	29.2	25	31.9
15	3.18	39	45	65	54	78	51	53	148	104	25	1	70.3	7	25.0	15	28.8	25	35.2
10	2.76	25	15	83	88	107	29	37	90	0	0	1	100.0	7	100.0			10	100.0
11	2.47	25	15	85	88	107	44	37	90	0	0	1	100.0	7	100.0			10	100.0

[1]This was brick and concrete chamber inside packing plant, not subjected to sun's heat and little affected by outside temperature. The maximum temperature here is for the container and not for outside.

included in the comparison because of the exceptionally short period of examination, the converse is true of those experiments conducted at the higher temperatures, for the ratio of revivals to subsequent deaths is roughly one to sixteen.

The trends of mortality percentages in the two groups of Oryzaephilus experiments are also very different. In the lower-temperature group the percentages of mortality decrease sharply from the first to the fifth day, finally attaining levels intermediate between the extremes of the first and the fifth day. Experiment IX, of this group, was not counted on the first day, the zero-day count being nearest to it in point of time. In the higher-temperature group, on the other hand, the percentages, excepting those experiments marked by continued perfect kills, in all instances were larger at each successive examination.

The lower-temperature group of Plodia experiments shows the same general condition observed with Oryzaephilus, except that here the revival period is much longer. It will be noted that revivals outnumbered subsequent deaths roughly three to one. In general, the percentages of mortality decreased to the fifteenth day and subsequently increased, establishing on the twenty-fifth day levels intermediate between those of the first and the fifteenth day. The Plodia experiments of the higher-temperature division are too few to serve as a valid comparison with the other group. Indeed, the two experiments placed here were made during an extremely hot period when the maximum during the day was 107°F. and the minimum at night, 73°F.

While the association between revival and moderately low temperatures is obvious, it will be noted that in one experiment, the maximum temperature of which was 60°F., the kill of both Oryzaephilus and Plodia was perfect, and there were no revivals. This experiment, aside from having been performed under the lowest temperature here included, was conducted in a chamber of exceptional tightness. Thus, with the practical elimination of the leakage factor, revival was lacking despite the suitability of the temperature for such reaction. These circumstances indicate that although moderately low temperature is the primary condition favoring revival, insofar as temperatures above 60°F. are concerned, some imperfection of fumigation must contribute to the production of the revival phenomenon. In other words, the revival of these insects from the effects of carbon disulphid results from a combination of moderately low temperatures and one or more of the common imperfections of fumigation, such as leakage, inadequacy of the charge, insufficiency of the exposure, variation in the grade of carbon disulphid, penetration factor of the package, etc.

Since temperatures below 78°F. under natural conditions markedly affect both the insects and the fumigant, the immediate effect of such temperatures responsible for revival is obscure. In other words, is revival induced by the retarded metabolism of the insect or by the lessened activity of the fumigant resulting from the moderately low temperature? Both of these effects are important, but much investigation is necessary before their relative weight can be shown.

Methods of Determining Revival

The tests employed in determining revival involved very slight disturbance of the fumigated insects, as discussed above. However, even this degree of agitation does not ordinarily affect those insects left in the product after fumigation, and the question may be raised as to whether such disturbance was promotive of revival to a greater extent than would have obtained if left perfectly quiet and revival gauged by visual examination only.

Experience in handling the fumigated individuals under discussion provides no indications that revival is induced by disturbance of the character and extent here practiced. It is possible, however, that our method operated to reveal a slightly higher degree of revival than would have been shown by visual examination. For instance, it was noted that some Plodia larvae responded to touch very feebly for a few days, but died without any appreciable extension of the power of movement. Had such larvae been observed by eye only they might not have been recorded as having revived. Our method operated similarly with regard to Oryzaephilus adults. It should be added that revival of both species has been observed in the absence of any disturbance save that involved in the initial count as ordinarily made. Despite the possibility of our method yielding slightly higher extremes of revival as compared with revival obtaining among insects left undisturbed, there is no basis for believing that the extent of survival of revived individuals likewise would be augmented.

Subsequent Death

Subsequent death, as employed in this paper, covers both the delayed death of insects surviving fumigation, and the subsequent demise of revived individuals. In either case such deaths, as will have been noticed previously, have an important bearing upon the calculation of effectiveness of fumigation operations against Oryzaephilus and Plodia when employing carbon disulphid.

Some portion of the subsequent deaths doubtless represents indi-

viduals sufficiently impaired by the treatment so that ultimate recovery is impossible under any circumstances. It is believed, however, that a considerable percentage of such belated deaths, particularly in the case of Oryzaephilus because of the greater number used in experiments, is attributable to the confinement and crowding to which the insects were necessarily subjected during the protracted examination. A further factor, believed to have an especial bearing upon subsequent death in experiments conducted during summer, is the temperature to which the treated insects in vials were subject during the protracted examination. During summer in the San Joaquin Valley many objects indoors, including the vials containing the insects, are almost daily heated to 90°F., and they frequently attain temperatures between 95°F. and 100°F., while occasionally this temperature exceeds 105°F. Certainly one must concede that, were the surviving and reviving insects free to disperse and establish themselves in suitable locations, they would have far greater chance of ultimate recovery. If this reasoning be sound, the importance of insect revival is even greater than shown in certain of the experiments herein reviewed, for, whereas the effect of revival is partially counteracted by subsequent death due to the arbitrary handling of the test lots, a still greater proportion of the revivals among those insects naturally occurring in the fumigated product would ultimately survive.

Practical Importance of Revival

The point of practical value established by the above results relates to the necessity of extended examination of lots of insects planted in, or of individuals collected from, the treated product for the purpose of determining the effectiveness of fumigation operations with carbon disulphid. The unreliability of the 24-hour interval, or of a 48-hour period, for that matter, is clearly shown.

In general, the percentage of mortality is apt to fluctuate up or down subsequent to a brief interval following fumigation. In several experiments more living individuals were revealed by the final counts than by the examinations made twenty-four hours after treatment. Furthermore, it has been demonstrated that some of the revived Plodia larvae ultimately produced moths.

For Oryzaephilus adults the extreme interval between fumigation and revival encountered in this work was *ten days*. Those few individuals recorded as reviving at or near the end of the protracted examination have been excepted because they doubtless represent earlier revivals which were overlooked. Indeed, it is believed that the extreme interval

more correctly approximates seven days, due to the ever-present possibility of some artificial extension of the actual period of revival because of occasional mistaken assignment of living beetles to the dead batch, and the subsequent discovery that they were living. For Plodia the extreme revival interval was *fifteen* days. One larva which revived eleven days after fumigation later attained the imaginal condition.

The length of our protracted counts was determined by the observed revival of the two species. Except in unusual instances the counts were continued several days beyond the cessation of revival. The periods used are, then, believed to be appropriate for the insects used and the conditions obtaining in these experiments.

In view of these considerations the question naturally arises as to what may be considered a proper interval after fumigation to check results of the operation. In the first place, the interval apparently varies with the species of insect; certainly it is very different for Oryzaephilus adults and Plodia larvae. Even when viewing the record established through protracted examination for a given species in a single fumigation, the opposing and overlapping trends of revival and subsequent death make most difficult the selection of a particular interval which is manifestly a true indication of effectiveness. Furthermore, variation in different fumigations of one or more of the several pertinent conditions has the effect of advancing or retarding the revival period. Since, in commercial fumigation, these governing factors cannot accurately be gauged, it appears to the authors impracticable to establish any arbitrary interval which would constantly provide a correct expression of effectiveness. Rather, several examinations must be made. The final count does not provide a fair indication of the kill effected because it reflects the probable death, as above discussed, of some individuals due to the untoward conditions of confinement during the protracted examination. Therefore, in dealing with the data herein recorded, the maximum revival, or minimum kill, appears to be the most satisfactory index of effectiveness. However, in the light of the above discussion concerning the possible influence of methods upon recorded revival, this basis of gauging effectiveness may be held slightly to undervalue the benefits of the operation. Notwithstanding, it is regarded as the most accurate, uniform indication available.

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Scientific Notes

The Quantity of Fish Oil to Use as an Adhesive in Lead Arsenate Mixtures. In Bulletin No. 1439 of the United States Department of Agriculture, entitled "Fish Oil, an Efficient Adhesive in Arsenate of Lead Sprays," it was recommended that 4 quarts of fish oil be used to 400 gallons of spray mixture containing 25 pounds of powdered lead arsenate. Experiments conducted since this bulletin was submitted for publication have shown that the amount of fish oil should depend on the amount of lead arsenate that is used and that 3 quarts is sufficient for 25 pounds of powdered lead arsenate. If the amount of lead arsenate is reduced or increased, the fish oil should be reduced or increased proportionately. This should be the rule regardless of the amount of water used, but does not apply to mixtures containing Bordeaux.

For every pound of powdered lead arsenate contained in the spray mixture add 4 ounces by weight of fish oil.

CLIFFORD E. HOOD,
U. S. Bureau of Entomology, Melrose Highlands, Mass.

Can Baits be Used in Scouting for Injurious Insects? During the season of 1926, the writers conducted experiments with baits in apple and peach orchards in Maryland with the view of capturing the codling moth, *Carpocapsa pomonella* L., and the Oriental fruit moth, *Laspeyresia molesta* Busk. In an apple orchard baited for the codling moth, 13 moths of this species and 17 moths of the Oriental fruit moth were captured. In two peach orchards over 19,000 Oriental fruit moths were taken. The baits used in these tests included syrups diluted with water and evaporated fruits suspended in water.

The results of these investigations suggested to the writers that the practical application of facts derived from research in insect chemotropism might well be extended from the field of control, where its importance is now recognized, to that of scouting for injurious species in suspected areas not known to be infested.

Attractive baits for insects other than those mentioned above are already known,

and it therefore seems reasonable that such materials could be utilized to advantage to supplement ocular inspection in scouting for these pests. Further experience may show that the application of chemotropism in scouting for injurious insects may prove of equal if not of greater value than in insect control.

E. H. SIEGLER and LUTHER BROWN,
Deciduous Fruit insect Investigations, United States Department of Agriculture, Bureau of Entomology

The True Identity of the Citrus Mite. A good deal of confusion has existed among various authorities in recent years as to whether or not the citrus mite and the deciduous red mite are the same species. Certain entomologists have claimed that both of these red spiders are identical with the European red mite, *Paratetranychus pilosus* C. & F.

The present writers have always maintained that the citrus mite, *Paratetranychus citri* McG., is entirely distinct from the European red mite of deciduous trees. About two years ago the undersigned contributors undertook to settle the matter beyond argument, if possible. The problem was undertaken both through rearing tests and further anatomical studies. Citrus mites were sent from Southern California to Yakima, Wash., where Mr. Newcomer attempted crossing the male citrus and the female deciduous forms, and the male deciduous with the female citrus forms. Checks were conducted where citrus males and females were bred, and where deciduous males and females were reared. In addition, deciduous mites were sent from Yakima, Wash., to Lindsay, Calif., where an attempt was made by Mr. McGregor to rear them on citrus foliage.

A paper should appear before long in one of the leading scientific journals which will present in detail the results of these studies. We feel that it may not be amiss at this time to briefly announce the outcome of these studies, without supporting our findings by data of any sort.

It was found that the citrus mite would not breed with the deciduous mite, nor would the deciduous mite maintain itself successfully on citrus trees. Specimens of the European red mite, sent to us from Germany, proved to be entirely different in their anatomy from the citrus mite.

These facts have led us to reach the final conclusion that the citrus red spider of California and Florida is a distinct species, apart from that of the deciduous red mite. The proper technical name of the citrus mite is *Paratetranychus citri* McG., while the deciduous red mite will probably continue to be called *P. pilosus* C. & F.

E. A. McGREGOR,
E. J. NEWCOMER.

Common Insect Pests Prefer Other Host Plants in Haiti. It comes as a considerable shock to an experienced Entomologist to find some common insect, with whose habits he considers himself reasonably familiar, under different circumstances or in another country occurring on quite a different host. "La Pulga Americana" (the American flea-beetle) of the Porto Rican tobacco growers, *Systena basalis* J. Duval, is by no means confined to tobacco or to Solanaceous plants even in Porto Rico, but one ordinarily finds it in greatest abundance on such hosts, and supposes its presence on other plants to be more or less accidental. How upsetting to all preconceived ideas, then, to find what appear to be considerable numbers of the same beetle in Haiti feeding on the leaves and calyces of cotton! There is no question

about the indentification, for Dr. Schwarz confirmed it; the cotton was not some special variety occurring only in Haiti, but Meade cotton; the beetles were feeding on the cotton because they liked it and not because of the absence of a more suitable host, for many acres of tobacco were near-by, yet on the tobacco no beetles could be found. There was no explanation; it was merely so. This observation was made at St. Michel, Haiti, in February, 1925.

The Pumpkin Bug, *Nezara viridula* Linn., is most often recorded from the Lesser Antilles on cotton, but one thinks of it in the Greater Antilles as a pest of garden vegetables, especially tomatoes and peppers. There is one Porto Rican record of its occurrence on tobacco at San Lorenzo in 1921 and causing considerable damage, but the first personal observation on this host was at Cap-Haitien, Haiti, in January, 1927. Blackened and withered central buds and tips of the larger leaves of the tobacco plants showed in a striking way the apparent injury caused by these big green bugs. The grower was surprisingly unconcerned, claiming that the withered plants would recover in a few days, especially if the abundant rains continued, but admitted that the effects might be really serious during dry weather. All stages of the insect were present in abundance in the tobacco field, and the evidences of the feeding of the adults and large nymphs were everywhere to be seen. Despite its absence in tobacco fields in other parts of Haiti, and its abundance on other hosts, *Nezara viridula* was far too common in the tobacco fields at Cap-Haitien for its presence and its choice of a host plant there to be considered an accident.

GEORGE N. WOLCOTT, *Port-au-Prince, Haiti.*

Increasing Nicotine Evolution from Tobacco Dust.[1] The use of tobacco dust for the control of different insects has not increased in proportion to its importance, mainly due to the slow volatilization of the nicotine. Under certain conditions tobacco dust might be preferable over nicotine dust mixtures if nicotine evolution can be increased.

A series of laboratory experiments were conducted during 1924 and 1925 with tobacco furnished by the Kentucky Tobacco & By Products Company. The tobacco was ground to pass a 200 mesh sieve, and had after grinding a nicotine content of 1.53%. The material was slightly alkaline.

The tobacco dust was mixed in different proportions with hydrated lime, dolomite and Miltown Ball Clay No. 9. After the nicotine evolution was compared from these mixtures the most promising received small quantities of sodium carbonate. Two grams of the mixtures were distributed with the aid of a pepperbox over cheesecloth clamped between the upper and lower parts of a Novy bacterial culture apparatus used in our studies on nicotine evolution (N. J. Agr. Exp. Sta. Bul. 400). Air conditioned to a relative humidity of 73.4% was drawn through the apparatus at a rate of 6 liters in 10 minutes for a period of 72 hours and at a temperature of 80°F. One sample was kept dry and another running parallel moistened at intervals to simulate dew. The latter samples were moistened with tap water blown from an atomizer (5 blows) after 7–8 hours run, this moistening was repeated after 28 hours. There the sample remained dry for the first 7–8 hours, was moistened and run for 24 additional hours, then moistened again and left for the rest of the 72 hours. The parallel sample was left dry during the whole period.

[1]Paper No. 332 of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

The results for the mixtures running 72 hours in percentage nicotine evolved are given in Table 1. When the mixtures were kept dry tobacco dust alone evolved more nicotine than when mixed with any one activator tried. Tobacco dust moistened released less nicotine than dry, the same being the case with mixtures of tobacco dust and Miltown Ball Clay. Nicotine evolutions increased considerably from moistened tobacco dust mixed with lime and dolomite. Additions of small quantities of sodium carbonate to the mixtures practically doubled nicotine evolutions.

The nicotine in the dust is driven off by the alkali; when the mixture is moistened the alkali will penetrate better into the tobacco and consequently when such mixtures are placed in the soil near a plant to be treated or sprayed when dew has access to them nicotine will be released more rapidly. Miltown Ball Clay is acid in character and does not have this effect but in contrary holds possibly part of the nicotine evolving from the tobacco.

TABLE 1. PER CENT OF NICOTINE EVOLUTION FROM MIXTURES KEPT DRY AND MOISTENED AT INTERVALS

No.	Mixture (by weight)		Nicotine evolved	
			dry	moistened
3	Tobacco dust alone		3.83	3.16
5	Tobacco 50, $Ca(OH)_2$ 50		1.42	8.17
6	Tobacco 50, Dolomite 50		1.34	8.79
7	Tobacco 50, Miltown Ball Clay No. 9	50	1.42	1.34
8	Tobacco 50, Dolomite 45, Na_2CO_3	5	1.57	16.91
9	Tobacco 50, Dolomite 47, "	3		14.90
10	Tobacco 50, Dolomite 49 "	1		16.02
12	Tobacco 50, $Ca(OH)_2$ 49 "	1		20.56

WILLEM RUDOLFS

The Tulip or Iris Aphid in Santa Cruz County, California. *Anuraphis tulipae* Boyer de Fonscolombe has been for several years a pest of more or less serious nature to bulbs around Santa Cruz, Calif. While no protracted studies of this insect have been attempted by the writer, some observations of interest are herewith reported. In this district the bulbous iris appears to be the favored host and the infestation is most serious during the summer months while the bulbs are in the storage shed. Accordingly the insect is termed the "storage aphid" by many of the growers. As the American Association of Economic Entomologists has recommended the common name "tulip or iris aphid," the term "storage aphid" should be discouraged. The commercial growers of Santa Cruz County have trouble with this aphid on only one other group of plants, viz., the Mourning Iris, *Iris susiana*, one of the rhizome types. Tulips are not grown commercially in this section.

From the reports of the horticultural commissioner's office of Santa Cruz County and of the growers it is evident that the infestation was quite heavy in the summer of 1924. However, in 1925, no infestation of even the slightest degree was noted by any of the iris producers, and several searches by the writer failed to locate any specimens whatever. During the past summer (1926) all growers had trouble with this aphid, and the writer had no difficulty in locating infested iris bulbs in any of the warehouses. One contributing cause of the non-appearance of the aphids in 1925 is the fact that practically all iris bulbs were fumigated during the infestation of 1924.

During the summer and autumn of 1926 the writer kept about 500 infested iris bulbs in the laboratory. Commencing about September 10th and continuing to approximately October 15th there was a marked production of winged forms which congregated in considerable numbers on the laboratory windows. Examination of some of the bulbs during this period showed that these winged forms were coming from both plump and shrivelled bulbs, indicating that conditions outside of the bulbs rather than the drying of them were causing this phenomenon. Winged and wingless specimens collected at this time were identified by Dr. P. W. Mason of the Bureau of Entomology as *Anuraphis tulipae* Boyer. (Authorship of this species is sometimes indicated "Fonsc.;" the full name of the author is Boyer de Fonscolombe.)

Box fumigation with calcium cyanide has been considered by the various growers as very satisfactory in controlling attacks of this aphid. During the 1924 season they used dosages of from eight to sixteen ounces of calcium cyanide per 100 cubic feet with exposures of two hours duration. This was spread directly on burlap sacks soaked in water, so that full evolution of the hydrocyanic acid gas was not obtained, but there is little doubt that the resulting concentration was sufficiently high to kill all aphids, and none of the growers reported injury to their bulbs. The writer made three tests with granular calcium cyanide in August 1926, with the following results:

Rate		Number of aphids dead	Number alive	Mortality %
A.	1.76 oz. per 100 cu. ft.	522	1	99.8
B.	2.35 oz. per 100 cu. ft.	1204	0	100.
C.	2.35 oz. per 100 cu. ft.	664	0	100.

In these tests the exposure lasted two hours.

The writer's method of application was to place a damp (*not* soaking wet) sack on the floor of the fumigation box, over which three or four thicknesses of dry newspaper were laid, and to spread the material thinly over the paper.

Fumigated iris bulbs from these tests and from several fumigations by various growers were watched closely for evidence of injury, but nothing was observed to indicate any harmful effects.

It is probable that the amount of calcium cyanide could be reduced considerably if the period of exposure was prolonged, but in view of the fact that there is no injury at an approximate rate of two ounces per 100 cubic feet, the two hour exposure is deemed more desirable as the additional labor cost with longer exposures would be much greater than the saving in cost of material.

CHARLES F. DOUCETTE, *U. S. Bureau of Entomology, Bulb Insects Field Station, Santa Cruz, California*

Note on the Continuous Breeding of *Musca domestica*. The difficulty of rearing house flies during the winter months, and the importance of maintaining a continuous supply during the entire year for experimental uses and insecticide tests, induces the writer to publish the following note on a successful method for meeting the seasonal difficulties in this field.

In earlier publications,[1] it was stated that, "Two species of flies, namely, *Musca domestica* and *Stomoxys calcitrans* have been reared from approximately the middle

[1]The effect of food on longevity and reproduction in flies. *J. Exp. Zool.*, 1923, xxxviii, 383–412. Rearing flies for experimental purposes, with biological notes. *J. Econ. Ent.*, 1924, xvii, 486–496.

of April until the middle of December. The artificial conditions (artificial heat, food, etc.) seem to manifest their influence at this time, however, for it has so far been impossible to rear these flies during the remaining four months of the year." Since the summer of 1924, up to March, 1927, house flies have been continuously bred. No further attempts at breeding *Stomoxys* throughout the winter were made, but doubtless can now also be accomplished if the further directions, outlined below, for *Musca domestica* are followed.

It often occurs that when all of the conditions, enumerated in the articles referred to, are fulfilled with respect to adult and larval food, to moisture of the larval medium, to temperature and atmospheric humidity, cultures cannot be maintained. Sometime during December or January fertile female house flies will oviposit; the progeny grow to about half their normal size and then die. Experience has demonstrated that the medium (horse manure in this case) is more deficient in food value for fly larvae in winter than during the warmer months. Whether this is due to a change in the bacterial flora on which maggots reared on certain foods primarily feed; whether it is due to a reduction in the number of bacteria for some reason, or due to some other factor, correlated with the horse's winter diet, is unknown. Neverthless, it has been found that when fly larvae in winter cease to grow the addition to the manure every few days of a few cubic centimeters of a heavy suspension of yeast cells in water will correct matters and will enable the larvae to grow and mature. This procedure has also proven valuable in cases of overcrowding where too many eggs are laid and consequently more maggots emerge than the food value of the medium can support. In practice we dissolve a one pound bakery cake of commercial yeast in two liters of water. The suspension of yeast cells is then distributed in pint milk bottles and autoclaved, to kill fungi which often cause trouble, and stored on ice. When addition of yeast to the larval diet is indicated the suspension, which rapidly settles, is shaken vigorously and added every two or three days in amounts dependent upon the number of maggots present in a breeding jar.

Lastly, fresh horse manure should always be used for each new generation of flies. I have found that some investigators, at times, attempt to use the same manure for two or more generations and complain at the total loss of their flies. It should also, be emphasized again that the manure must be maintained in a moist condition. For the proper feeding of the newly emerged adults and for other details the reader is referred to the articles mentioned.

R. W. GLASER, *Department of Animal Pathology of the Rockefeller Institute for Medical Research, Princeton, N. J.*

REPORT OF CONFERENCE OF ENTOMOLOGISTS AND PLANT PATHOLOGISTS AT LOGAN, UTAH, FEB. 9 AND 10, 1927

A conference of the Entomologists and Plant Pathologists of the Rocky Mountain region was held at the Utah Agricultural College in Logan on February 9 and 10, 1927. The conference was called by Director William Peterson of the Utah Agricultural Experiment Station to consider some of the insect and disease problems common to Utah and the surrounding states. The following program was carried out:

Introductory remarks—Director William Peterson.

Wireworms and their control—M. C. Lane.

The chalcis fly in alfalfa seed—C. J. Sorenson.

A statement of the beet leafhopper problem—I. M. Hawley.
Economic aspect of the beet leafhopper problem—R. H. Cottrell.
Present status of the investigation of the sugar-beet leafhopper—Walter Carter.
The curly leaf disease—Eubanks Carsner.
Storage rots of sugar-beets—C. M. Tompkins.
Minor diseases of sugar-beets—B. L. Richards.
Agronomic control—George Stewart.
Beet breeding—E. G. Titus.
Sugar-beet root-maggot—I. M. Hawley.
Alfalfa diseases—B. L. Richards.
Status of alfalfa weevil investigation—Geo. I. Reeves.
Showing of the alfalfa weevil film—property of the U. S. D. A.
Difficulties in control of alfalfa weevil—Claude Wakeland.
Prevention of spread of the alfalfa weevil—G. G. Schweis.
Current problems connected with the alfalfa weevil—Geo. I. Reeves.
The alfalfa weevil in the Mississippi Basin—C. L. Corkins.
Introduction of alfalfa weevil parasites—I. M. Hawley.
Some of the more important insect problems in the United States—J. E. Graf.
Summary of the work of the conference—Director William Peterson.

At the conclusion of each paper time was allowed for a general discussion. These discussions were a great aid to a better understanding of the various problems.

On Wednesday evening following the first day's conference, the staff of the Utah Experiment Station entertained the visitors at a banquet. Geo. I. Reeves acted as toast master.

A resolution committee consisting of I. M. Hawley, C. W. Hungerford, E. G. Titus, R. H. Cottrell and H. J. Pack was appointed by Director Peterson. Acting on the suggestion of this committee it was decided to hold a conference during February, 1928, in Salt Lake City. Director Peterson was asked to act as chairman of the meeting next year.

The following representatives of the U. S. Department of Agriculture were in attendance:

Bureau of Entomology:

J. E. Graf, Washington, D. C.; Geo. I. Reeves, I. M. Hawley, S. J. Snow, Salt Lake City, Utah; Walter Carter, Twin Falls, Idaho; E. W. Davis, Richfield, Utah; M. C. Lane, Toppenish, Washington.

Bureau of Plant Industry:

Eubanks Carsner, Riverside, California; Dean Pack, S. B. Nuckols, Gerald Thorne, Salt Lake City, Utah; C. M. Tompkins, Logan, Utah.

The following state experiment station workers were in attendance:

Wyoming: C. L. Corkins.

Idaho: Claude Wakeland, C. W. Hungerford, R. W. Haegele.

Nevada: G. G. Schweis.

Colorado: J. H. Newton.

Utah: Director William Peterson, P. V. Cardon, W. W. Owens, W. W. Henderson, H. J. Pack, C. J. Sorenson, G. F. Knowlton, B. L. Richards, F. B. Wann, H. L. Blood, Geo. Stewart, D. W. Pitman, D. C. Tingey, J. W. Carlson, G. Q. Bateman.

In addition, the Utah State Department of Agriculture was represented by F. E. Stevens, E. L. Barrett and W. W. Knudson; the American Smelting and Refining Company by A. F. Barney; the Utah-Idaho Sugar Company by E. G. Titus, and the Amalgamated Sugar Company by R. H. Cottrell, S. Christensen and eight field men.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1927

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.
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A ten million dollar European corn borer campaign sets a new record in control work and is really a test in possibilities of organization and cooperation, since it is proposed to depend largely upon individual farmers to clean-up their own cornfields and corn waste, the government and state officials providing directions, supervision and later cleaning up areas not properly cared for, either through neglect or for some other cause. The clean-up is to be completed by May 1, easily possible with an early spring and favorable conditions. The corn belt is rightly exercised over the advance westward of the European corn borer and as a consequence general cooperation can be more easily obtained than were conditions different. There may be some difficulty in impressing upon thousands of individuals the need of close attention to details and it may prove something of a problem to do within the time limits the supplementary work made necessary for one reason or another. The plan is sound in emphasizing possibilities of control through modifications in agricultural practice and if this can be thoroughly demonstrated, this feature alone may justify the expenditure. This undertaking must result in a considerable decrease in the infestation in the more badly infested areas and thus lessen materially the probability of rapid spread. The execution of the project will be watched with the greatest interest. It is something new for America, intriguing in its scope, and demanding the support of all those in position to render material aid. There must be no sparing of effort to demonstrate possibilities in this gigantic undertaking.

Current Notes

Mr. E. Hobbs, Entomologist at Substation No. 15 of the Lower Rio Grande Valley, Texas, has resigned.

Mr. H. L. Fackler has recently been appointed assistant entomologist of the Tennessee Station, Knoxville, Tenn.

Mr. H. L. Seamans of the Lethbridge, Alta, Laboratory, addressed students of the Raymond Agricultural School on "Insects and Their Control," on January 21.

Dr. L. O. Howard, Chief of the U. S. Bureau of Entomology, spoke at Cornell University on January 27, on "Fifty Years of Economic Entomology."

The Department of Entomology of the Arkansas University and Station, will be housed in a new agricultural building now being erected at a cost of $250,000.

Messrs. B. R. Coad and Elmer Johnson left Tallulah, La., on December 30, for an extended trip to Arizona, where they will study the Thurberia weevil situation.

Mr. J. N. Tenhet of the Bureau of Entomology, returned December 31, to Clarksville, Tenn., from his temporary assignment with the Federal Horticultural Board at Houston, Texas.

Mr. Henry H. Richardson, a graduate of the Massachusetts Agricultural College, has recently been appointed Junior Entomologist, to fill a vacancy at the Gipsy Moth Laboratory, Melrose Highlands, Mass.

Mr. H. G. Crawford, Entomological Branch, Ottawa, Canada, gave a lecture on "The Control of Insects Affecting Farm Crops," at an Agricultural Short Course at Russell, Ontario, on February 4.

Mr. H. F. Barnes, who has a traveling fellowship from the Southeast Agricultural College, Wye, England, is spending the winter studying gall midges with Dr. E. P. Felt, at Albany, N. Y.

According to *Science*, the extensive collection of Coleoptera accumulated by the late Mr. Fred C. Bowditch of Brookline, Mass., has been presented by his family to the Museum of Comparative Zoology, Cambridge, Mass.

Dr. M. Kamal has recently completed his studies in the United States and is returning to Cairo, Egypt, where he will be employed in entomological work by the Ministry of Agriculture.

Messrs. L. L. Huber and R. M. Salter presented a paper on "Corn Borer Research in Ohio," at the 19th annual meeting of the American Society of Agronomy held at Washington, D. C., November 18–19, 1926.

Messrs. Blanchard and Luginbill of the United States Federal Laboratory at Monroe, Mich., visited the Chatham, Ontario, laboratory on January 22, to secure host material for rearing *Exoristes* and *Habrobracon* parasites.

Mr. K. M. King of the Saskatoon, Sask. Laboratory, visited Regina, Sask., January 25–26, and conferred with certain provincial officials in connection with the continuation of the excellent cooperation enjoyed during 1926.

Dr. Charles H. O'Donoghue, Professor of Zoology, University of Manitoba, Winnipeg, visited Ottawa on January 5, and spent some time with the Dominion Entomologist and other Branch officers, discussing various matters of entomological interest.

Dr. J. M. Swaine, Associate Dominion Entomologist, and Ralph Hopping, Specialist on Forest Insects for the Canadian Government, were in Washington recently studying insect collections and conferring with specialists on forest insects of the department.

Mr. G. M. Stirrett, of the Chatham, Ontario Laboratory, attended a European corn borer conference held at London, Ontario, on January 27. The conference brought together those in charge of the enforcement of the provincial European corn borer control legislation.

Professor William E. Hoffmann, head of the Biology Department of Lingnan University, Canton, China, represented the University and South China at the Third Pan-Pacific Science Congress recently held in Tokyo, where he gave papers on entomology and parasitology.

According to *Experiment Station Record*, Dr. C. H. T. Townsend has been placed in charge of the Peruvian Agricultural Institute of Parasitology, which has recently been organized to study the insect pests and plant diseases of the coastal region of Peru.

Dr. B. A. Porter, in charge of the laboratory of the Bureau of Entomology, at Vincennes, Ind., spent the latter part of December and a part of January in Washington, conferring with Bureau officials regarding plans for the coming season's work.

A corn borer exhibit was displayed at the Peninsular Winter Fair held at Chatham, Ontario, in the early part of December. Messrs. A. B. Baird, G. M. Stirrett, and H. F. Hudson assisted in giving information to the public on insect control.

Dr. A. A. Granovsky, of the University of Wisconsin, spent several days in January at the Bureau of Entomology, studying aphids with Dr. Mason. Dr. Granovsky is especially interested in the Callipterini and is working on a monograph of this group.

Mr. G. G. Ainslie, formerly in charge of the Knoxville, Tenn., laboratory of the Bureau of Entomology, resigned from the Bureau service, effective January 31, 1927, for the purpose of entering commercial work. His address, as formerly, will be Knoxville, Tenn.

Mr. G. A. Ficht, now of the Department of Entomology, Iowa State College, Ames, was a visitor at the Chatham, Ontario, laboratory at the end of December in connection with the securing of corn borer material for exhibition work in Iowa.

Dr. Philip Luginbill, of the Monroe, Mich., corn borer laboratory, and D. S. Lacroix, of the Sandusky, Ohio, corn borer laboratory, were at Toledo, Ohio, on January 24, for consultation with D. J. Caffrey relative to winter phases of the investigational work.

Mr. L. S. McLaine gave an address entitled, "Some Problems of the Entomologist," before the Lion's Club of Ottawa, on January 11, and one on "Small Friends and Foes," illustrated by motion pictures, before school children, at the Victoria Memorial Museum, Ottawa, on February 12.

According to *Science*, Professor Mario Bezzi, the well-known authority on the Diptera of the world, has been appointed professor of zoology and director of the zoological museum in the Royal University of Turin, Italy, as a successor to the late Professor E. Giglio-Tos.

Mr. R. P. Gorham of the Fredericton, N. B. Laboratory, visited St. John, N. B., January 13–14, where he conferred with Dr. William McIntosh of the Natural History Museum, concerning the history and location of recent armyworm outbreaks in the province, and their possible recurrence in 1927.

Mr. Perez Simmons of the Bureau of Entomology reports that recently he and G. W. Ellington discovered that the Angoumois grain-moth larvae sometimes leave the grain and spin cocoons in the ground. This is a new fact that appears never before to have been recorded.

Mr. C. H. Gable, formerly in charge of the San Antonio, Texas, laboratory of the Bureau of Entomology, resigned from the Bureau, effective December 31, 1926, to enter commercial work. Mr. E. V. Walter, of the Tempe, Arizona, laboratory, has been placed in charge of the laboratory at San Antonio.

According to *Science*, Professor C. T. Brues, of Bussey Institution, Harvard University, spent the early part of the winter at the Harvard Tropical Laboratory at Soledad, Cuba, investigating the insect fauna of the region. He was accompanied by Mrs. Brues, who made studies of the local grass flora.

According to *Science*, during February, Professor Wesley R. Coe of the department of zoology at Yale University, who is absent on sabbatical leave for the college year, was engaged in investigations of the invertebrate fauna of the Pacific Coast, with headquarters at the Scripps Institution of Oceanography in California.

Dr. George H. F. Nuttall, Quick Professor of Biology, and Director of the Molteno Institute for Parasitology at Cambridge, England, gave the Gehrman lecture at the University of Chicago, January 11, on "Insects and Disease." He lectured on the three following days at the University of Illinois, giving one lecture on "Ticks."

Professor A. W. Baker and Mr. R. Ozburn, of the Entomological Department, Ontario Agricultural College, Guelph, visited the Entomological Branch at Ottawa, December 28 to January 4, and with the assistance of officers of the Division, made a selection of duplicate insect specimens from the National Collection, for incorporation in the College collection at Guelph.

On November 26 and 27, the State Plant Board of Mississippi, together with entomological workers of that State, held a meeting at A. & M. College, Miss., at which Mr. Oliver I. Snapp of the Bureau of Entomology, gave an address on the results of recent experiments on the control of peach insects in the South.

Mr. E. R. Buckell, Vernon, B. C. Laboratory, attended the meetings of the British Columbia Stockbreeders' and Fruit Growers' Associations held at Vancouver in the early part of December. While in Vancouver, Mr. Buckell held consultations with several officials and made arrangements for provincial cooperation in grasshopper and Colorado potato beetle control work during 1927.

Mr. W. J. Brown, M.Sc., has been appointed to the position of Assistant Entomologist, Entomological Branch, Ottawa, dating from January 31. This position became vacant on the resignation of Mr. H. L. Viereck in April, 1926. Mr. Brown, who has specialized in coleoptera, was formerly a lecturer in entomology at the Oklahoma Agricultural and Mechanical College, Stillwater, Okla.

At a meeting of the Entomologists Group of the Professional Institute of the Civil Service of Canada, held at Ottawa on December 17, Dr. W. H. Brittain, Professor of

Entomology at Macdonald College, Quebec, gave an interesting, amusing and informative address on certain aspects of his recent trip around the world undertaken in the interests of the American Cyanamid Company.

At the annual meeting of Massachusetts gipsy moth superintendents, Boston, January 18, brief addresses were made by Dr. W. A. L. Bazeley, A. F. Burgess, George A. Smith, H. L. McIntyre, Dr. T. J. Headlee, W. C. O'Kane, H. L. Bailey, and Dr. W. E. Britton. Most of these men took part in a conference the preceding afternoon on methods to be followed in gipsy moth work.

A description of the "Modified Electro-Gutzeit Apparatus for the Detection and Estimation of Minute Amounts of Arsenic in Insect Tissue and in Arsenical Residues" will appear in the Journal of Biological Chemistry. Those desiring a reprint of the article should communicate with Dr. D. E. Fink, Dept. Zoology, University of Pennsylvania.

According to *Science*, Dr. William Schaus, Honorary Assistant Curator of Insects, U. S. National Museum, has recently purchased and donated to the Museum a collection of moths from Bolivia containing about ten thousand specimens. This is a large and important addition to the Museum's collection of South American moths, which is believed to be the largest in the world.

Mr. S. E. McClendon, Bureau of Entomology, Thomasville, Ga., reports that the fall examinations of corn grown and housed on St. Simons Island, Ga., showed that no rice weevils were present. This fact is of interest because, when the control experiments were started on this island about four years ago, the rice weevil was a very serious and widespread pest.

Mr. George I. Reeves, in charge of the Salt Lake City Laboratory of the Bureau of Entomology, spent December 13 and 14 at Ames, Iowa, in consultation with Professor Carl J. Drake, of the Iowa State College of Agriculture, regarding the spread of the alfalfa weevil, and addressed the faculty and advanced students of the Department of Zoology at that college.

Mr. C. E. Petch, of the Hemmingford, Quebec, Laboratory, delivered several addresses on various phases of entomology before the Men's Club and the Boys' Club of the Y. M. C. A., at Sherbrooke, and the Men's Industrial Classes at Sherbrooke High School, early in January. He also gave a lecture on "Insects of the Flower Garden," before the Women's Institute, Hemmingford, on January 7.

According to *Science*, Dr. T. D. A. Cockerell, Professor of Zoology at the University of Colorado, expects to sail for England next June, and thence go to Russia and Siberia, later back to Russia; in October to England, and about November 1 to India; about February 1, to Australia and New Zealand by way of the South Sea Islands, returning to Boulder, Colo., about September 1, 1928.

Professor W. C. O'Kane has recently been elected a member of the Authors' Club of London, England, and last summer was elected to membership in the Authors' Club of New York. The committees responsible for the selection of new members in both clubs indicated that the recent books on the White Mountains and the Green Mountains are the literary works that have brought this honor to Professor O'Kane.

Dr. Edith M. Patch, Entomologist of the Maine Station, will spend several months in England the coming summer, where she will continue her investigations

of economic species of aphids. Her plans include sailing from St. John, N. B., on April 8, on the Montcalm, and her laboratory headquarters will be at the Rothamsted Experimental Station, Harpenden, Hertsford, England. Dr. Patch will be accompanied on the trip by her sister, Miss Alice S. Patch.

Mr. R. B. Falkenstein, Instructor in Biology at Lingnan University, Canton, China, has returned to America on furlough, returning via Siberia and Europe. His place is being filled by Mr. R. E. Wall. Both Mr. Falkenstein and Mr. Wall were formerly of the staff of the University of Minnesota. The head of the Biology Department at Lingnan University, Professor William E. Hoffman, is also a former member of the staff of the University of Minnesota.

Mr. Arthur Gibson, accompanied by Mr. L. S. McLaine, attended the 21st annual convention of the Ontario Horticultural Association held at Toronto, Ontario, on February 10 and 11, and spoke on the subject, "Inspection of Nursery Stock." Delegates were in attendance from the various horticultural societies throughout Ontario. The organization, comprising as it does all the local societies, has a membership of 70,000. About 500 delegates were in attendance at the Toronto meeting.

For the period ending January 21, 1927, the shipments of corn borer parasite material from Europe included a total of 84,000 cocoons of *Microgaster tibialis* Nees, 12,500 cocoons of *Eulimneria crassifemur* Thom., and 645,000 host larvae, from which five additional species will be reared. These shipments will be continued and supplemented by laboratory rearings. Preliminary shipments of parasite material from India and from Japan have also been received through the cooperation of the Japanese beetle investigators.

In 1926, the Dominion Entomologist of Canada arranged for the sending to New Zealand of living Chrysopids collected in British Columbia, in the hope that they would assist in checking the ravages of certain destructive aphids. Owing to the success attending this shipment, further arrangements were made to send a second shipment, and this, consisting of over 5,000 living individuals, was dispatched to New Zealand in December. Messrs. E. R. Buckell, A. A. Dennys, and W. Downes assisted in the collecting and dispatching of this material.

Acting on instructions from the Dominion Entomologist, the officers of the Hemmingford laboratory, Messrs. C. E. Petch and G. H. Hammond, made collections of parasitized white grubs, consisting of over 1500 specimens, for shipment to Dr. David Miller, Government Entomologist at Wellington, New Zealand. It is hoped that the parasites, which belong to the species *Microphthalma michiganensis*, will establish themselves in New Zealand and assist in the control of chafers of the genus *Odontria*. Dr. Miller has announced the safe arrival of the parasitized material.

On January 19, about 1500 persons attended the special session on the European corn borer, held in connection with Farmers' Week, at the Auditorium of the College of Agriculture, University of Illinois, at Urbana. Addresses on the corn borer were given by D. J. Caffrey of the Bureau, R. M. Salter of the Ohio Agricultural Experiment Station, R. I. Shawl of the University, and Theo. Brown. The new moving picture films of the corn borer were shown, and a special corn borer exhibit was also displayed. Dr. S. A. Forbes presided at the session.

Observations in the past few months have shown a very heavy mortality of the San José scale in the Georgia peach belt; heavier than at any other time in the last

five years. It is believed to be due to twice-stabbed ladybird beetles. In many cases the scale coverings, with no bodies under them, were found clinging to the trees. The question has arisen whether the unusual abundance of ladybird beetles in 1926 is in any way correlated with the general use of lubricating-oil emulsion for the last several years.

A conference of entomologists and commissioners of agriculture was held at the Japanese Beetle Laboratory, Riverton, N. J., February 10. Among those present were Dr. A. L. Quaintance, Associate Chief, Bureau of Entomology, Washington, D. C.; C. H. Hadley, Director Bureau of Plant Industry, Harrisburg, Pa.; Dr. T. J. Headlee, State Entomologist, New Brunswick, N. J.; Dr. W. E. Britton, State Entomologist, New Haven, Conn.; Loren B. Smith and C. W. Stockwell, Japanese Beetle Laboratory, Riverton, N. J.; W. C. Duryea, Commissioner of Agriculture, Trenton, N. J.; R. B. Willson, Commissioner of Agriculture, Dover, Del.; and B. D. Van Buren, Assistant Director Bureau of Plant Industry, Albany, N. Y.

Mr. D. M. Rogers, Assistant in charge of the gipsy-moth quarantine and inspection work of the Bureau of Entomology, has resigned from the service. He had been associated with the gipsy-moth work for many years. He was the first man employed by the Bureau when the gipsy-moth work was begun in 1906, and had been in charge of quarantine and inspection since 1913. He and Mrs. Rogers have gone to California, where he plans to carry out experiments in plant breeding. Dr. J. N. Summers, associate entomologist in the Bureau, connected with the gipsy-moth investigations since June, 1911, has been appointed to the position left vacant by the resignation of Mr. Rogers.

According to the *Official Record*, Mrs. C. V. Riley, widow of Doctor Riley, predecessor of Dr. L. O. Howard as chief entomologist of the Department, has donated to the library of the National Museum the scrapbooks of economic entomology which were kept by her husband in the period of his activity from 1865 to 1894. These volumes, about 100 in number, contain many articles of great historical interest. In giving these scrapbooks to the Museum, Mrs. Riley wished to have them housed in the same place as the Riley collection of insects. The donation is of great importance to entomologists, as it makes available much information otherwise very difficult to obtain.

A corn borer conference was held at Chicago on January 21 and 22, to standardize recommendations for the proper use of existing plow equipment and accessories thereof, to meet the requirements of the corn borer clean-up campaign this spring. The conference was attended by experts of the large manufacturers of farm machinery. Representatives were also present from the Agricultural Engineering Departments of Michigan, Indiana, Ohio, and Pennsylvania. Prof. A. L. Wiancko, of the Agronomy Department of Purdue University, and Mr. Smith, President of the County Agents' Association, attended. The Bureau was represented by L. H. Worthley and D. J. Caffrey. Professor C. O. Reed, of the Agricultural Engineering Department of Ohio State University, presided.

Recent visits to the Division of Insects, U. S. National Museum, have been made by the following entomologists: Dr. H. W. Allen, Riverton, N. J., December 2 and 3; Dr. C. J. Drake, Ames, Iowa, December 24–26; Drs. H. B. Hungerford, Lawrence, Kansas, and D. M. DeLong, Columbus, Ohio, December 27; Dr. M. Kamal, Cairo,

Egypt, December 24; Dr. W.A. Riley, St. Paul, Minn., December 14 and 15; G.M. Greene, Harrisburg, Pa., December 31; G. B. Merrill, Gainesville, Fla., December 24 and January 3–5; Dr. H. Prell Tharandt, Saxony, Germany, December 13–23; H. F. Barnes, Wye, England, Christmas week; Graham Fairchild, Harvard University, Christmas week; Dr. J. M. Swaine, Ralph Hopping, Ottawa, Canada, January 3; Dr. E. D. Ball, Sanford, Fla., January; Dr. S. B. Fracker, Madison, Wis., January 1; Dr. T. H. Frison, Urbana, Ill., January 3–5; Dr. W. J. Holland, Pittsburgh, Pa.

A hearing was held in Washington, D. C., February 8, by the Federal Horticultural Board regarding the proposed extension of the European corn borer quarantine. The quarantine has been extended (effective March 1) to include Bayonne and Jersey City, New Jersey; much extra territory in Pennsylvania; Staten Island, Kings Queens, and Nassau Counties, Long Island, New York; Charlestown, Narragensett, North Kingston, South Kingston and Westerly in Rhode Island; and the towns of East Lyme, Groton, New London, Stonington and Waterford in Connecticut. Among the entomologists present were noted: Frank N. Wallace, State Entomologist, Indianapolis, Ind.; C. H. Hadley, Director, Bureau of Plant Industry, Harrisburg, Pa.; E. N. Cory, State Entomologist, College Park, Md.; W. E. Britton, State Entomologist, New Haven, Conn.; P. A. Glenn, Chief Nursery Inspector, Urbana, Ill.; C. L. Marlatt, E. R. Sasscer, W. H. Larrimer and L. H. Worthley of the Bureau of Entomology.

At a conference of representatives of the Committee of the international European corn borer organization and representatives of the Department of Agriculture, held in Washington early in January, the need for a careful administrative consideration of the research program in reference to the control of the European corn borer was made plain. In view of the emergent character of the situation, it seemed important that there be called a similar conference of the station directors in the states concerned, to consider the research now in progress bearing on the problem and to map out a research program for the coming season, in which the various states join with the Department. Such a conference was called by Dr. A. F. Woods, Director of Scientific work, to meet in Washington, January 6 and 7. The conference was attended by station directors, entomologists, agronomists, farm machinery engineers, and other representative officials of the Corn Belt and of states not immediately in that area. The research program of the Department was outlined in detail, and the many investigational phases bearing either directly or indirectly on the problem of control were freely discussed. The research programs of the various states concerned were presented and likewise discussed. It was the general opinion of those in attendance that practically nothing had been omitted from the combined program of the Department and the states, and while the enlargement of some of the projects was arranged for, no new lines of work were suggested.

Horticultural Inspection Notes

Four winter nests of the brown-tail moth have recently been found at Wolfville, N. S.

Mr. W. N. Keenan gave an address on "The Work of the Division of Foreign Pests Suppression," before the Gyro Club of Fredericton, N. B., on January 11.

The Central States Plant Board held its annual meeting at Madison, Wis., on March 4 and 5 in connection with the meeting of the North Central States Entomologists.

Mr. L. M. Scott of the Federal Horticultural Board recently made a trip to Philadelphia, New York and Boston to confer with the men in charge of these ports.

Mr. R. W. Woodbury, who has been employed as a Plant Quarantine Inspector in Washington for about two years, was recently transferred to Boston to assist in carrying on the work at that port.

Detroit, Mich., has been designated as a port of entry for plant material, and an Inspector will shortly be appointed to look after the interests of the Federal Horticultural Board at that place and at Port Huron.

Mr. Spessard, Plant Quarantine Inspector of the Federal Horticultural Board, stationed at Washington, D. C., has been detailed temporarily to look after the Board's work in Baltimore in the absence of Mr. Prince, who is away because of illness.

As these notes are being prepared we have just been informed of the death of Mr. Nile M. Border. Mr. Border has been associated with the Federal Horticultural Board as an inspector stationed at New York and Philadelphia since September 5, 1925.

Mr. E. R. Sasscer of the Federal Horticultural Board is visiting the Mexican border ports to investigate some of the problems which have arisen, and to confer with the Inspectors in charge of the work. He expects to touch at all of the points on the border where Inspectors are stationed before returning.

Mr. Max Kisliuk, who has charge of the work of the Federal Horticultural Board at Philadelphia, has been detailed to make an investigation of the fruit fly situation in the Argentine Republic. Mr. William W. Chapman was placed in charge during Mr. Kisliuk's absence which will probably extend for a period of three or four months.

A ship from Argentina, which docked at Portland recently to discharge a part of its cargo of 14,000 bags of linseed, was found to have one of its holds badly infested with European earwig. The linseed was immediately loaded in freight cars, where it was given a heavy fumigation, and the boat allowed to proceed to Seattle where the vessel was fumigated to kill the insects.

The European Corn-borer Quarantine No. 43 has been extended following the public hearing at the Department of Agriculture held February 8, 1927. The extension involves the inclusion in the infested area of portions of two new states—Connecticut and New Jersey—and minor additions in Rhode Island and New York. A revision of the regulations under the Corn-borer quarantine, indicating these extensions, to be effective March 1, has just been issued.

Mr. E. M. Ehrhorn recently resigned his position as chief of the Plant Inspection Service for the Board of Agriculture and Forestry in the Hawaiian Islands. He has been succeeded by Mr. D. T. Fullaway, who was formerly engaged in collecting and rearing parasites of the more important insect pests of the Hawaiian Islands. Mr. L. A. Whitney remains as Associate Plant Inspector. Mr. Fullaway and Mr. Whitney are both collaborators of the Federal Horticultural Board.

It is with sorrow that we have to report the recent death of Mr. R. I. Smith, who for many years has been prominent in Entomological work. He has been associated since August, 1915 with the Federal Horticultural Board, and has had charge of its inspection work at Boston. Through Mr. Smith's untimely death the Board has lost a faithful worker, one whose place it will be difficult to fill, and those who were closely associated with him, a true friend.

The rules and regulations under the Foreign Corn-borer Quarantine (No. 41) have been revised effective January 1, 1927. The quarantine itself is unchanged. Under the revised regulations the entry of products covered by the quarantine is limited to clean shelled corn, clean seed of broom corn and broom corn for manufacture. Corn and seed of broom corn may be imported only under permit, and under requirements of inspection and certification from the country of origin. Reinspection of these articles will also be made at port of entry. Other restrictions on the entry of broom corn for manufacture remain unchanged. This quarantine now replaces and supersedes Quarantine No. 42 against Indian corn or maize from Mexico.

Apicultural Notes

The annual winter meeting of the North Carolina State Beekeepers' Association was held during the latter part of January at Raleigh, N. C.

A commercial organization of intermountain beekeepers to be known as "Mountain States Honey Producers Association," was formed at Laramie, Wyoming, during a meeting held there from February 21–24.

Recent visitors at the Bee Culture Laboratory of the Bureau of Entomology included Professor Francis Jager, of the University of Minnesota, and Mr. C. L. Sams, Specialist in Beekeeping, of the North Carolina State College of Agriculture and Engineering.

At the January meeting of the Arkansas Beekeepers' Association at Little Rock, a bee disease bill was recommended which provides for a full-time state bee-disease inspector, registration of all bees in the State, and a tax of ten cents per colony. The passage of the bill seems assured.

A radio program on bees and honey by the American Honey Producers' League, in cooperation with the Extension Service of the University of Wyoming, was scheduled for March 22 from the Laramie broadcasting station. Dr. A. P. Sturtevant, in charge of the Intermountain Bee Culture Field Station, and Professor C. L. Corkins, State Entomologist, were on the program.

Pacific Slope Notes

During the latter part of February, Mr. J. E. Graf visited the western stations of the Division of Truck Crop Insects in Idaho, California and New Mexico.

The Pacific Slope Branch will hold its annual meeting at the University of Nevada, Reno, Nevada, June 22 to 24 inclusive.

Beginning in January, 1927, the Monthly Bulletin of the California State Department of Agriculture resumed publication, after being temporarily suspended in June 1923.

Mr. W. Downes of the Victoria, B. C., laboratory gave an address on "Insect Conditions in British Columbia," before members of the Entomologists Group at Ottawa on January 28.

Mr. Walter Carter, in charge of investigations on the sugar beet leafhopper, located at Toppenish, Wash., visited the Alfalfa Weevil Laboratory at Salt Lake City on December 15.

Mr. E. J. Newcomer, Associate Entomologist, in charge of the Bureau of Entomology field station at Yakima, Wash., attended the spray residue conference held at Salt Lake City, Utah, February 21–22.

Mr. Joseph C. Chamberlin, Assistant Entomologist at the Citrus substation, Riverside, Calif., has resigned to accept a teaching position in the Department of Biology of the San José State Teachers College.

Weevil infestations have been found in cotton of the 1926 crop at or near the following points in Arizona: Sahuarita, Continental, Tubac, Nogales, Bowie, San Simon, Willcox, Light, McNeal, and Elfrida.

Mr. A. G. Fuller has been appointed as temporary insect pest investigator at Vancouver, B. C., to inspect shipments of nursery stock and plant products entering Canada through that port. His work will be under the general supervision of Mr. W. H. Lyne, Chief Provincial Inspector at Vancouver.

Mr. E. P. Venables, Vernon, B. C. laboratory, visited Spokane, Wash., early in December, to attend a conference on oil sprays. As a result of this conference it is planned to develop cooperative tests, etc., during 1927, in various fruitgrowing districts in British Columbia, Washington and Oregon.

Messrs. J. C. Hamlin and W. D. Reed, of Fresno, Calif., in the early part of November fumigated more than half a million dollars' worth of dried fruits with sulphur dioxide, carbon disulphide, and hydrocyanic-acid gas. These were practical fumigations on a large scale and gave valuable results.

Dr. Olive Swezy has been appointed agent of the Bureau of Entomology in cooperation with the California Experiment Station at Berkeley, Calif., to work with Dr. H. H. Severin in studying the nature of the virus which causes curly-top of sugar beets, and is transmitted to the beets by the sugar-beet leafhopper.

Messrs. E. J. Newcomer and M. A. Yothers, Associate Entomologists of the Bureau of Entomology, with headquarters at Yakima, Wash., attended the annual meeting of the Washington State Horticultural Society at Wenatchee, Wash., in December. Mr. Newcomer discussed "Oil Sprays," and Mr. Yothers presented a paper on "Codling Moth Trap Baits as a Supplementary Control Measure."

Mr. Yothers was called to Hood River, Oregon, January 10, where he addressed the fruit growers of that section on the use of trap baits in controlling the codling moth. On February 12 he visited Kennewick, Wash., where he discussed the same matter, and on the same day he returned to Yakima, where he repeated his discussion.

During October, Dr. E. A. Back of the Bureau of Entomology visited California to consult with Bureau specialists working with stored-product insects. On the way out and while he was on the Coast he inspected some work of private firms of interest to the Bureau. Of especial interest were the heat and fumigating rooms constructed for the treatment of furniture, and the work of firms actively engaged in moth-proofing fabrics.

The third meeting of the Entomological Club of Southern California was held at Alhambra on March 11, with an attendance of more than 50. The morning was spent in a discussion of methods of determining the degree of insect infestation, with particular reference to citrus scale insects and codling moth. In the afternoon the two new Department of Agriculture corn borer films were shown, and Mr. George P. Weldon gave a talk on "Education in Economic Entomology." Although less than a year old, the club membership now exceeds a hundred. There will be future meetings of the Club on June 10, September 9 and December 9, at Alhambra, Calif. All visiting entomologists are welcome.

Notes on Medical Entomology

Dr. William A. Hoffman of the School of Tropical Medicine at San Juan, P. R., spent a few days in the Division of Insects, U. S. National Museum, studying the biting gnats of the genus Culicoides and related forms.

As a result of an organized campaign of trapping the screw worm fly carried out by County Agent W. R. Nisbet and some twelve ranchmen over a large area in Menard County last year, widespread interest in the matter of controlling the screw worm fly by systematic trapping, as outlined by the United States Bureau of Entomology, has been manifested. A meeting of livestock raisers was held in Menard on February 24, at which representatives of other livestock-raising districts were present. Screw worm control was discussed by F. C. Bishopp and O. G. Babcock of the Bureau of Entomology, and the results of the local organization were presented by Mr. Nisbet. Figures of last year showed that in parts of the county where trapping was not carried out, about eight per cent of the livestock was infested by screw worms, while in the district where trapping was done the number of infested animals was reduced to less than one per cent. Following this meeting the ranchmen began the organization of several fly-trapping areas.

Errata

Page 16, line 21, for quality, read quantity

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SECTION OF PLANT QUARANTINE AND INSPECTION

Tuesday Morning, December 28, 1926

The session of the Section of Plant Quarantine and Inspection of the American Association of Economic Entomologists, held in the Logan Hall, University of Pennsylvania, Philadelphia, Pennsylvania, December 28, 1926, convened at nine forty-five o'clock, Mr. C. H. Hadley of Harrisburg, Pennsylvania, presiding.

CHAIRMAN HADLEY: In the absence of Mr. Strong, who is Chairman of this Section, I have been asked to start the ball rolling. One of the first duties is to appoint a Nominating Committee to report later. I therefore, appoint the following: J. E. Graf, Chairman, G. M. Bentley and L. S. McLaine.

The program as outlined calls for the address of the Chairman, Mr. Strong, who is not here; therefore, we will go on to the next number.

THE EFFECT OF THE SUPREME COURT DECISION OF MARCH 1, 1926 IN THE CASE OF THE OREGON-WASHINGTON RAILROAD AND NAVIGATION COMPANY VS. THE STATE OF WASHINGTON, ON THE BASIC QUARANTINE LAWS OF THE VARIOUS STATES

By C. L. MARLATT, *Washington, D. C.*

ABSTRACT

A good many States are considering at this time revision of their basic plant quarantine laws in so far as they affect interstate movement of plants and other articles, to bring them in alignment with the amendment of April 13, 1926, of the Federal Plant Quarantine Act, of August 20, 1912.

Inquiry is frequently made as to the extent of State quarantine action possible under the first proviso of the amendment of April 13. This inquiry is often specific, namely, whether a State may act with reference to some district (State, territory,

etc., or portion thereof) which is not covered by the Federal quarantine as to the *subject*, or whether it may act as to additional restrictions above or beyond those specified in the Federal quarantine.

In answer, attention may be drawn to the fact that the decision of the Supreme Court referred to evidently eliminated from State enactment or enforcement all plant quarantine legislation designed to control or regulate interstate traffic in plants and plant products with respect to dangerous plant diseases or insect infestations. The amendment of April 13 restored to the States this power of interstate control and regulation only to a limited extent, for it will be noted that the power thus restored has reference specifically to the *subject*, that is, the disease or insect, and that such power as to *subject* may be exercised only until the Secretary of Agriculture has made a determination as to the necessity of a quarantine and established such a quarantine with respect to the dangerous plant disease or insect infestation. Therefore, under this amendment, a State may act only as to such disease or insect as is not the *subject* of a Federal quarantine, irrespective of any opinion as to the adequacy of the territory covered in the Federal quarantine or the adequacy of the regulations and restrictions established thereunder with respect to interstate movement of products.

As examples, the Secretary of Agriculture has made the necessary determinations and has established quarantines with respect to the pink bollworm, the Thurberia weevil, the gipsy and brown-tail moths, the white pine blister rust, the black stem rust of wheat, and other subjects; all such subjects are therefore eliminated from any State regulatory action on their account, affecting the interstate movement of plant or plant products or other articles. On the other hand, such subjects as the Mexican cotton boll weevil, the alfalfa weevil, the potato tuber moth, the citrus canker, and the chestnut blight, have not been made the *subject* of Federal quarantines and State regulatory control as to movement into or through the State with reference thereto would seem to be permissible.

With respect to subjects, that is, plant diesases or insect pests, which are covered by Federal quarantines, if any State believes that the protection afforded thereby is inadequate as to either district covered or restrictions, or that the restrictions are too drastic for the purpose intended, application for the desired change, as the Supreme Court has said, "must be obtained through application to the Secretary of Agriculture." In cases of emergency, action can be taken by the Department of Agriculture with great promptness.

If, on the other hand, it were possible for a State to act under the first proviso of the amendment with respect to any *district* not included under the Federal quarantine as to the *subject*, or if it were possible for a State to act as to *additional restrictions* as to interstate movement above or beyond those specified in the Federal quarantine, we would have again a mixture of State and Federal action as to the same *subject*, namely, action more or less in conflict and resulting in a state of confusion even worse than that existing prior to the Supreme Court decision of March 1, 1926.

In giving this opinion, it is not to be inferred that it is necessarily the last word on the subject, but rather what appears to be the plain intention and meaning of the first proviso of the amendment, in view of the Supreme Court's decision of March 1, 1926.

Attention is also called to the circular letter under date of April 26, 1926, sent to State plant quarantine officials, giving the opinion of the Acting Solicitor of this

Department on the question "Whether the decision of the Supreme Court in the case of the Oregon-Washington Railway and Navigation Co. vs. the State of Washington nullified all previous State plant quarantines or portions thereof regulating or controlling interstate traffic."

CHAIRMAN HADLEY: Is there any discussion?

DR. WILMON NEWELL: I would like to ask Dr. Marlatt for information on one point. I think we all clearly understand the effect of the Supreme Court decision upon state laws passed subsequent to March of 1912, in so far as those state laws undertook to regulate interstate commerce. What was the effect of that Supreme Court decision upon portions of those same laws which did not have anything to do with interstate commerce? In other words, that portion of the state law relating to interstate commerce was rendered ineffective by the Supreme Court decision. Did that automatically render the entire act of the state ineffective?

DR. MARLATT: I want to preface anything I say in answer to these questions as expressing merely my opinion and judgment, because after all I am not the court of last resort.

If a state has a basic plant quarantine act or law under which it operates both as to internal control of plants on account of pests and also with respect to movement of products into the state, I think it would be a reasonable interpretation that the only illegal part of that statute would be the portion relating to the interstate movement. The Supreme Court decision was very specific all the way through in making its statements apply to interstate movement.

DR. NEWELL: Then as to laws framed after the passage of the National Plant Quarantine Act, the situation would be remedied by amending only that portion which had to do with interstate commerce. Is that correct? And the balance of the act would remain valid despite the fact of its having been passed subsequent to 1912?

DR. MARLATT: That would seem to be a reasonable interpretation.

CHAIRMAN HADLEY: I might say in connection with Mr. Newell's question, that with reference to our Pennsylvania Horticultural Inspection Act, where that same question is involved, we have an informal opinion from our attorney general that only the portion of our act which might relate to interstate movement would be affected. It so happens that apparently our act when originally drawn was passed on recognition of the fact that an interstate package became subject to state jurisdiction only when it was finally delivered at the point of destination, so that our act apparently starts in at that point, and

according to our informal opinion so far, will require no changes, but that is not as yet definite. We are still working on it.

MR. S. B. FRACKER: Dr. Marlatt's reference to the Florida Narcissus quarantine affects probably all the quarantines that will be taken under the third proviso. I would like to ask Dr. Marlatt whether he is willing to suggest a wording for the Florida regulation which would obviate the difficulty that he pointed out. That is, if he is willing to give a general wording that could be adapted to such situations.

DR. MARLATT: I have no wording, Mr. Fracker, that could be definitely incorporated. My thought on the subject is something like this. "That each state, territory, and so forth, should provide by law police powers which would enable the state to cooperate under this proviso, powers which would authorize the seizure, destruction or the removal from the state of articles entered in violation of a Federal quarantine."

I think general language of that type would give any state authority to act with respect to any Federal plant quarantine subject. It does not set forth the idea that the entry in the state of any particular article is prohibited, which might be questioned.

MR. L. R. WARNER: If the state should put through a rule which would give the police power to the state to enforce Federal quarantines and if the state in carrying out those Federal quarantines should have to go into litigation and proseoution, would they do it under Federal court or state courts?

DR. MARLATT: The language of the proviso doesn't say the state shall have power to enforce the Federal quarantine. If they take such action as they see fit under state power, that would be state action enforced from the state police courts.

MR. J. H. MONTGOMERY: Dr. Marlatt referred to a state act of Florida with respect to the Narcissus quarantine. It may be well at this time to make some reference to the circumstances leading up to the action of Florida and why that action was taken. It must be borne in mind that the Narcissus bulb quarantine of Florida was imposed under our present plant act. That is the only act that we can operate under.

In order to prevent the introduction of these various pests, shipments into and within the state were to be made in conformity with the regulation of the Federal Horticultural Board. The thought we had in mind in promulgating that regulation was that it would parallel exactly the provisions of the Federal requirements and would not conflict in any way with the regulations of the Federal Horticultural Board.

The other thought we had in mind was that under this phraseology it would not be necessary for our own state organization to be making frequent changes in its quarantine regulations to conform to any changes which might be made by the Federal Horticultural Board. In other words, this would be a standard regulation and would virtually enforce under state conditions the regulation promulgated by the Federal Horticultural Board. Those are the two thoughts we had in mind. It must be borne in mind that we were operating under a law which was questionable; we have not yet had an opportunity to have that law revised or amended.

MR. GEORGE A. DEAN: A point came up about drafting a change in our laws, giving the state authority, as Dr. Marlatt suggested, to seize any article shipped into the state in violation of the Federal law. If the state did amend its law in such a way that it would have that authority, could the Federal Horticultural Board deputize a state man to seize produce shipped in, in violation of the Federal law.

DR. MARLATT: I am glad Mr. Dean brought up that idea, because it opens up a point which I would like to cover briefly. I will answer "No," in the first place, to his question, because, unfortunately, the Federal authority is limited, and that is the large remaining weakness of the Federal Plant Quarantine Act; we have power to punish, imprison and fine for violation, but we have no power of seizure, of destruction of property or articles that have been shipped in violation of the Federal plant quarantine. That is the great weakness of the Plant Quarantine Act which we have endeavored for some years to get Congress to consider. In fact, we have a motion going now by which we hope to get an amendment which will give us power to seize and destroy or otherwise safeguard anything that is moved in violation of a Federal quarantine. It is just at that point that the states can furnish and do furnish a very valuable aid and this authority to cooperate under this proviso of the amendment to the extent of taking possession of, or safeguarding in any way the police powers of the state may permit, articles which are shipped in violation of the Federal quarantine, is of great value both to the state and to the general enforcement of the Federal quarantine. State police powers can do that. If they haven't such powers, they can get them, but the Federal Government is unable to do any seizing and destroying; hence, they could not deputize, as you suggest, a state officer to do it.

MR. FRACKER: Dr. Marlatt suggested that a general provision of the statutes authorizing the states to pass restrictions on the introduction of plant material into the state would be invalid under an opinion of

the solicitors and that some recognition should be made of the Federal limitation in any such legislation. I would like to suggest to Dr. Marlatt that the solicitor's opinion in that particular be sent out to the inspection officers, because our various bills are being drafted at this time and it is very likely that those who are drafting these bills may unintentionally invalidate their own statutes by having them cover a greater breadth of subject than they should under the solicitor's opinion.

DR. MARLATT: I think that is a very good suggestion. I will say that I have already taken action along that line. I asked the solicitor to take this draft of a model state law, which you may recall was drawn up by Solicitor Morrill of the Department and which was a very good general type law, and revise it on the basis of the Supreme Court decision and of the amendment of the act. He has made a brief attempt at it, but in looking it over I find he has not yet nearly covered the subject. I hope to have something that can be sent out to the states, a specific section relating merely to that phase of it, which is all that would be necessary, because state laws are varied and the states will not want to change them all, but I would like to be able to put in the hands of the several plant quarantine officers of the states at least a suggestive draft of a section.

While I am on my feet I want to simply introduce another subject which is somewhat germane to this discussion, and has relation to state and Federal cooperation in plant quarantine work. You perhaps know our friends on the Pacific Coast have been very urgent for some years to have a sort of an annual conference on plant quarantine matters so that all subjects of interest could be thrashed out and a better understanding had with respect thereto. Recently Mr. Hecke and Mr. Strong of California made their appeal directly to Secretary Jardine on that subject, the thought being that the Secretary should call a conference whenever occasion required of the leading plant quarantine officials, or at least the leading official of each of the forty-eight states and perhaps some of our territorial possessions as well, for discussion of these problems, these men to be brought to Washington at Federal expense. That was the principal idea in Mr. Hecke's mind, because he felt it would be difficult to get the state to appropriate money to permit officers of the state to go long distances. The Secretary was impressed with the idea, and he has authorized us to look into it further and see if some plans can be worked out along that line. The idea is that we may have subjects arise on which a general conference of that kind might be of great value, as it was a few years ago when we had a general

conference similar to what we are discussing today, on the interrelation of state and Federal plant quarantine laws.

This is just thrown out as a piece of information. Something may come of it. In a way it butts into, perhaps, and infringes on the organization which has already been made by the states for group conferences, that is, the regional plant quarantine boards, and it seems to me that if we do anything in that line, we should take these boards into consideration so that we won't be treading on each other's toes and perhaps covering unnecessary ground.

CHAIRMAN HADLEY: The next paper is by Mr. L. S. McLaine.

THE PLANT INSPECTION SERVICE OF CANADA

By L. S. McLAINE, *Entomological Branch, Ottawa.*

ABSTRACT

The first federal pest legislation in Canada was the San Jose Scale Act passed in 1898, this Act was replaced in 1910 by the Destructive Insect and Pest Act. In accordance with the regulations of the latter Act, all plants entering Canada were subject to inspection or fumigation or both. In 1923 these regulations were revised, and importers are now required to secure permits to cover importations. Plants from countries other than the United States may only enter through specified ports and are subject to reinspection. Plants from the United States are not subject to reinspection but must be accompanied by a certificate of inspection and a certificate of fumigation unless exempt from treatment. For the year ending March 31st, 1926, 13,730 permits were issued to 6,354 different consignees. In all 5,555 inspections were made, the number of plants examined was 30,463,699. Pests and diseases were intercepted in 199 different consignments. Plant products were also examined, as well as passengers baggage, etc.

Canada like her neighbor to the south has within the past few years developed a very great interest in horticulture, floriculture and the allied industries. Horticultural societies are rapidly increasing in number each year and due to their efforts many small towns which a few years ago consisted of houses with lawns about them have been transformed into most attractive and artistic communities. The public are being educated as to the value of the use of flowers and shrubs and as a result there is a rapidly increasing demand for bulbs, roots, nursery stock, etc. Canada although covering a large area from the Atlantic to the Pacific has for the most part a short growing season. Many kinds of plants can be propagated economically and profitably at home, but in other cases it has been considered advisable to import them from other lands. Apart from the great increase in the amount of plant material propagated in Canada there has also been an increase in the material imported. In 1900 a total of $88,054.00 worth of plants was imported as compared with $1,109,413.00 worth for the year ending March 31st, 1926.

The first federal insect legislation in Canada was the San Jose Scale Act passed in 1898, which prohibited the importation entirely of trees, shrubs, plants, vines, grafts, cuttings or buds from the United States, Australia, Japan, and the Hawaiian Islands. This act was found to be so detrimental to the development of the horticultural and allied industries that it was modified two years later and the importation of the prohibited plants was permitted from the specified countries, provided they were routed on certain ports and there fumigated with hydrocyanic acid gas. In 1909 there was a serious outbreak of the brown tail moth in France, large imports of fruit stocks were being brought into Canada from Europe and inspection of these showed that many shipments were infested with this pest. There was no legal machinery in force at that time to require the inspection of such shipments, but through the whole hearted sympathy and co-operation of the importers who realized the seriousness of the situation, arrangements were made whereby all such importations were examined at destination. The fact that so many shipments were infested with a pest that was causing such serious damage in the New England states at that time brought about the realization of the danger of importing plants from foreign lands without suitable inspection, especially as it was found that fumigation had no effect on the hibernating brown tail caterpillar. In order to meet this situation the Destructive Insect and Pest Act was prepared and passed by Parliament in 1910. The Act provides for the Governor General in Council to make such regulations as are deemed expedient to prevent the introduction or admission into Canada or spreading therein of any insect pest or disease, destructive to vegetation. Although innumerable regulations have been passed in accordance with its authority, and on all manner of subjects, it has never been necessary to amend the Act itself. After the passing of the Act regulations were soon brought into force which required all importations of nursery stock to enter Canada through specified ports and at certain seasons of the year. Such shipments were subject either to fumigation or inspection, or both. The latter was carried on either at the port or destination.

By 1920 it was understood that insect and pest legislation had assumed such a complicated aspect, and involved so many different problems, not only as regards plants, but also plant products, as well as international trade, that it was considered advisable to constitute an Advisory Board to consider such matters. Early in 1922 the Destructive Insect and Pest Act Advisory Board was formed, and five officials of the

Department of Agriculture were appointed members. The Board is not empowered to pass legislation, but may recommend to the Minister of Agriculture any changes which are considered advisable and in the public interest, and also may call upon others to act in an advisory capacity. The Board itself does not administer the various regulations, but leaves their administration to the particular Branch concerned.

The first duty of the Board was to consider a general revision of the regulations then in force. The revised regulations consisting of a series of General Regulations and fifteen foreign and seven domestic regulations went into effect in September, 1923. The General Regulations consist of fourteen sections and are more or less comprehensive, they empower the Department to inspect or examine any plant or plant product offered for entry into Canada and if found infested with any pest or disease may be refused entry, treated or destroyed. This section is of particular value in the handling of importations not covered by any special regulation or order. Provision is also made for the inspection of export shipments, powers of inspectors, the right of trespass, the disposal of infested material, the importation of plants for scientific purposes, etc.

The foreign and domestic regulations deal with specific problems, they may be increased in numbers, amended or modified as occasion demands. The regulations of possibly the greatest interest are those dealing with the inspection of nursery stock.

Regulation No. 1 (Foreign) deals with the importation of nursery stock from countries other than the United States, and may be summarized as follows: The importer is required to secure a permit to cover his importation. Shipments may enter Canada through one of the following ports, St. John, N. B.; Montreal, Que., Niagara Falls, Ont., or Vancouver: B. C.; containers must be marked with the permit number, names and addresses of the consignee and consignor, quantity and nature of contents contained therein and a copy of the original certificate of inspection. Shipments may not be moved from the port of importation unless a certificate of inspection, or a certificate of clearance which permits the consignment to proceed to destination for inspection, is issued by an officer of this Department. All shipments entering Canada under this regulation are subject to reinspection. The inspection service is under federal control, with the exception of British Columbia where the work is carried on by provincial officers who act as collaborators of the federal service.

In addition to inspectors being stationed at the aforementioned ports of importation, there are a number of inspection districts scattered throughout the Dominion. Plants consigned to individuals situated in these districts, are usually not examined at the port of importation but are permitted to proceed to destination for inspection. In such cases the port inspector advises Ottawa that a certificate of clearance has been issued for the particular consignment and Ottawa in turn, notifies the district inspector concerned as well as the importer. The district inspector keeps in touch with the importer until the shipment has been examined and passed. The Department of Customs do not release shipments unless either one of the required certificates is attached to the shipping papers. If a certificate is missing it means that the shipment has been improperly routed. Small packages of plants may also be imported by mail. Official labels are furnished to the importer on request, these are forwarded by him to the shipper who affixes them to the parcel. Montreal and Vancouver are the mail inspection stations. On arrival at one of the above, the plants are examined and if passed are forwarded in bond to the customs house nearest to the address of the ultimate consignee, without the payment of additional postage.

Regulation No. 2 (Foreign) governs the importation of nursery stock from the United States. Under this regulation the importer is required to secure a permit, but the plants are not subject to reinspection in Canada, with the exception of shipments consigned to residents of the province of British Columbia, which must enter via Vancouver for examination, in accordance with the provincial regulations. This regulation further requires that all shipments of plants must be accompanied by a certificate of inspection and also a certificate of fumigation, unless the plants are exempt from such treatment. Both certificates must be signed by a federal or state official.

At the time this regulation was under consideration, the Board were of the opinion that with the well organized inspection services in the various states, arrangements could be made for the inspection of shipments intended for Canada, at the time of packing. That is, it would be carried out on the same basis as exporting countries are required to inspect before shipment, consignments intended for the United States. Unfortunately the results were not entirely as anticipated, in several states co-operation has been secured, whereas in others the only certificates issued are those in blanket form valid for a year or even longer, and based on the inspection of the nursery at some period during the growing season. In certain cases it has been almost impossible to secure

inspection certificates, covering greenhouse plants. Many of our commercial greenhouse men suffered severe financial loss due to importing plants infested with such pests as the Florida fern caterpillar, rose midge, chrysanthemum midge, leaf tyer, etc.

For the year ending March 31st, 1926, the following statistics with regard to the inspection service are available. A total of 13,730 permits was issued to 6,354 different consignees to cover shipments of plants from all countries. In all 5,555 separate inspections were made, consisting of 30,463,699 plants contained in 22,466 separate packages. In 199 different consignments pests or diseases of one kind or another were intercepted. At the port of Montreal 1,005 mail packages containing 94,082 plants were examined. Several species of plants are prohibited entry for specific pests or diseases; during the year 128 interceptions were made; in 106 cases permits were refused and 22 seizures were made by the inspectors, the plants involved by these interceptions totalled 13,490, which did not include 19 shipments of potatoes.

All passenger boats arriving at ports at which inspectors are stationed are attended at the time of disembarkation; 318 boats were attended at St. John, Quebec, and Montreal last year. Plants were found on 116 of these which were being brought in as baggage by 208 different passengers. Particular attention is paid to the port of Quebec during the season of navigation as this port is where the greater proportion of immigrants disembark.

In addition to plants, inspectors are engaged in the examination of plant products which arrive from all parts of the world; last season 5,692 separate inspections of these products were made, involving 1,049,833 packages, 83 shipments were infested with insect pests.

During recent years there has been a growth in the export trade of plants, etc. Last year 326 inspections of export shipments were made, for consignments going to nineteen different countries. The exports consisted of 283,676 plants; 106,766 bulbs; 4,430 pounds of forest tree seed, and miscellaneous shipments such as onion sets, tobacco plants, corn stalks, etc.

DR. MARLATT: Mr. Chairman, I want to call attention to one very attractive feature of the Canadian Act—its brevity and comprehensiveness. It is the shortest and most comprehensive and effective act that I know of in the whole history of plant insect pest legislation, and apparently it is adequate.

Some years ago when a request came from half a dozen states to draft for them a state law, and this Association was interested in drafting a state law, I took it up with our solicitors and the result was this state law which I mentioned a moment ago. It is a rather long one, but a good deal shorter than most state laws. I urged the solicitor to get one as short as the Canadian law. I gave him the Canadian law as a model that I wanted him to follow, but I was advised that the United States was different, that we were a different sort of a country, that we had Federal and state powers, and what the Federal Government could do and what the states could do was more or less limited and we couldn't get what we wanted in brief language like that. What they have is a certain named body having authority to do what is necessary—to prevent pests from entering the country or to eradicate them, and that is all that is necessary, but unfortunately we are not able to do likewise.

Chairman Hadley: If there is no further discussion, we will go on with the next paper.

ADVANTAGES AND DISADVANTAGES IN THE USE OF PRINTED CERTIFICATE TAGS

By S. B. Fracker, *Madison, Wisconsin*

Abstract

Printed nursery inspection certificate tags are subject to various kinds of misuse but constitute the only means of insuring growing-season inspection in advance of shipment. Such summer inspection is essential in the case of raspberry plants, white pines, currants and gooseberries, roses, elms, and other nursery stock. It is recommended that the use of printed certificate tags showing growing-season inspection be retained, but that additional safeguards be employed to prevent their misuse.

Since the establishment of nursery and plant inspection in the United States, two methods of attack have been developed in different sections and they have now grown so far apart that they might be said to represent two separate schools of thought among inspectors.

The earlier of these in time of introduction is the one now used almost exclusively in the northern, eastern and central states. This is based on the inspection of plants during the growing season by officers of the state in which they are growing, the issuance of an inspection certificate covering the entire premises, and the attachment of printed copies of this certificate to all bundles, boxes or carload lots of nursery stock shipped by the owner of the premises. This plan is based on the recognition of such certificates by the state of destination and the assumption that the certificate holders use the tags honestly.

The second method of attack consists of the inspection of all plants coming into a state or district, *after* they have arrived at their destination. This was developed in the south and west in the realization that valuable horticultural interests are more adequately protected when reliance is placed on the decision of their own employees as to the presence or absence of insect pests or plant diseases and the relative importance of such pests as are found on the stock. Such a plan involves neither the recognition of the work of other inspectors nor the assumption of honesty and carefulness on the part of the nurseryman and his employees.

In addition to these two methods, a third has been proposed, namely inspection of nursery stock while dormant at the time of shipment, and personal certification of each bundle by the inspector. Prior summer inspection could also be required when it was believed necessary.

The secretary of the section on Horticultural Inspection has asked me to discuss the relative soundness of these different points of view, particularly as the agricultural officers of leading western states are questioning the value of printed certificate tags covering and attached to shipments of nursery stock. Possibly their purpose is to lead up to a proposal that printed certificate tags be entirely discontinued.

Inseparable from the shipping tag problem is the difference in results which may be obtained from a growing-season inspection on the one hand, and dormant-season inspection on the other. If summer inspection is to be maintained it can be enforced only by a requirement that all nursery stock shipped or delivered bear a copy of an inspection certificate. If stock is inspected at destination, on the other hand, no certificate need be issued before shipment.

Taking up, first, the method of inspection at the point of production during the summer season, we find certain advantages and other pronounced weaknesses. In the first place, certain diseases show no symptoms which can be determined on the dormant stock, and growing-season inspection is essential to diagnose them. The Mosaic type of disease is the one which is attracting most attention at the present time. While only three states have published regulations on this subject, the northern and eastern states at least are now assuming that raspberry nursery stock is carefully inspected for Mosaic and that when inspection certificates are attached to it the plants may be assumed to have less than a certain minimum percentage of infection. No types of shipping point inspection or inspection at destination can take the place of certification of the premises when it comes to the shipping of raspberries

in the northern states at the present time. Dormant-season inspection is now wholly unacceptable to all the states with relatively large raspberry producing centers.

A similar situation exists with respect to the white pine blister rust. This disease cannot, ordinarily, be detected on the white pine within less than two or three years after the infection takes place. The presence of the disease in the vicinity, however, can be determined with comparative certainty and ease by an inspection of the currant and gooseberry bushes during the late summer. Preventing the further spread of the blister rust and its establishment in new localities depends almost entirely on the late summer inspection of the premises on which Ribes plants are grown and of the surroundings of pine-producing nurseries.

In many cases also, summer inspection is much more practical and efficient than the dormant season examination of the plants. Examples of insects and diseases more readily determined while the trees and plants are in full leaf are strawberry root lice, maple wilt, elm canker and cranberry falseblossom. Unless a shipment of nursery stock is certified as coming from premises on which these pests and diseases do not occur or are under control, the customer in the state of destination has no way of protecting himself against their establishment, as finding them during the dormant season is uncertain and in some cases impossible.

The weaknesses of the use of printed certificate tags following a summer inspection of the stock are also quite obvious. The first weakness of the plan is the fact that an insect which is either of no consequence or generally prevalent in the state in which the nursery stock is produced, may prove expensive or even disastrous at the point of destination. Certain sections of the west are attempting to keep horticultural districts entirely free from even such pests as the codling moth and such scale insects as might be called mildly injurious. In these cases certificates based on summer inspection are relatively worthless because the inspectors usually give no consideration to the ordinary and slightly injurious insects of their own vicinity. Even if they should attempt to take such insects into consideration, an infestation common in the neighborhood but absent from a nursery might become started in the nursery the week after the inspector left the premises.

Second, as to efficiency of inspection, it is probable that the examination of dormant stock for certain pests, such as San Jose scale and many other scale insects, can be carried on more rapidly and with greater certainty than the inspection of the trees standing in the nursery row in

full leaf. Insects and diseases attacking the roots ordinarily require a packing house inspection regardless of the general policy of the department doing the work. This applies, particularly, to crown gall, nematodes, and woolly aphis. Many kinds of plants should, therefore, receive both active and dormant season inspections.

A third and serious disadvantage comes from the misuse rather than the proper employment of such tags. Incidents will come to the mind of every inspector in which nurserymen have loaned certificate tags to their neighbors who desired to ship a bundle or two of nursery stock, or have placed the tags on stock which the inspectors have never seen, or have continued to use certificate tags after the certificate on which they were based has expired. These are really serious weaknesses and are great enough, in fact, to destroy the value of the tag when a state is in the position of Florida, attempting to protect herself against any possibility of the re-introduction of Citrus canker. A few states, by issuing serially numbered tags, sent from the inspection office, are able to correct this fault to a large extent.

In order to determine just how closely our own nurserymen follow the letter of the Wisconsin law, we recently requested all of them to send samples of their tags to the inspection office. The law follows most of those of the central and eastern states in requiring, that "every person selling or shipping nursery stock shall attach to the outside of each package, box, bale or carload lot so shipped or otherwise delivered, a tag or label on which shall appear an exact copy of his certificate. The use of tags or labels bearing an invalid or altered certificate and the misuse of any valid certificate is prohibited."

At the time of writing, 351 out of 497 certified Wisconsin nurseries have responded to this request.

The results are shown in the following table:

	Number	Per cent.
Tags not yet secured from printer	69	19.7
Owners expect to secure no tags	97	27.5
Tags incorrect or altered	50	14.5
Tags correct	135	38.3
Total replies received	351	100.0

Among the tags which were not exact copies of the certificates held by the owners, the most common fault was the alteration of the printed date on old tags. One of these dated back to 1916, one each to 1917, 1919, 1921, and 1922, four to 1924, five to 1925, and six to 1926. The most serious fault was that 37 of these tags used the old wording which listed "nursery stock" as having been inspected and released for ship-

ment, when only some special kind, such as "strawberry plants" or "ornamentals," was in fact covered by and stated in the original certificate furnished the owner.

Of the ninety-seven who stated that their nursery business was so limited and local that no certificate tags were used, thirty-one said they would have no stock for sale in the spring of 1927, and had asked for inspection for their own information only. This latter group, while of importance from several standpoints, does not include nurserymen who make interstate shipments, and needs no further consideration here.

The item of greatest interest developed by this investigation, therefore, is the fact that 50 of the 185 tags received, were either altered in ink or were not "exact copies" of the inspection certificates as they purported to be. If the printers correctly print the 69 jobs now in their hands, the total proportion for the spring of 1927, would be, unless corrected, 50 incorrect tags to a total of 254, or 20% in error.

These figures decidedly weaken confidence in certificate tags when the nurserymen are allowed to supply them, even tho the 20% are smaller concerns probably shipping less than 1% of the stock on the market, and even tho we have no evidence that uninspected stock was sold or shipped under the altered tags.

Perhaps at this point, Wisconsin nurserymen should be relieved of the burden of unusual carelessness in the handling of certificate tags. We have at the office a small museum of tags from other states at least equally faulty. Even nurserymen are not solely to blame, for bundles of nurserystock arrive uninspected every year from one of the strictest of the Pacific coast states bearing unauthorized permit tags. We picked up this fall a certificate tag from another Pacific coast state, signed by an official inspector, but omitting both the number and name of the shipper and the point of shipment and therefore bearing no clew to his identity! Federal blister rust inspectors pick up expired certificates every year from many states.

In other words, the trouble is with the system of issuing certificates and expecting hundreds of nurserymen to secure correct copies of them. Some are sure to misuse or carelessly abuse the privilege.

If we now examine the method of inspection at destination, we find that this plan also has certain advantages and other disadvantages. Most of these have already been mentioned. The county or state inspector at the point of arrival can open a box of nursery stock and determine with speed and certainty whether or not scale insects are

present, or whether there are bark lesions on the trees indicating such diseases as apple canker and chestnut blight. He can also carry out the policy needed in the particular location in which the trees are to be planted and he is under pressure, political or economic, to protect the customer in every possible way.

In addition to these points, the purchaser knows that the certificate when attached to the box covers the exact stock contained in the box and not something else which the nurseryman found convenient to include.

The weaknesses, as indicated a few moments ago, are, first, that the inspector is unable to determine whether raspberry plants are free from Mosaic diseases, whether white pine may recently have become infected with the white pine blister rust, whether rose midge is present on greenhouse roses, or whether elm canker may be attacking the elms, and he would have difficulty in convincing himself that strawberry root lice and rootworms were absent from the strawberry plants and, possibly, even that maple wilt was not present on the maples.

So far as the northern states are concerned, there are also several administrative difficulties relating both to funds and to personnel, which prevent the adoption of inspection at destination. The cost of maintaining an inspector at every point of destination or even in one locality in a county is much beyond the funds now available. Even if adequate appropriations were secured for this, however, in states without extensive horticultural interests, it would be almost impossible to get competent local men to take over this responsibility during the spring months. The work is so seasonal that a full-time twelve-month crew of adequate size could not be maintained.

An additional weakness is the fact that when inspection is confined to destination only one express agent and only one inspector are responsible, while every transportation company employee en route and several inspectors may be able to check on tags attached before shipment.

When the secretary asked that this paper be prepared he did not indicate that the author should attempt to point a way out of the dilemma. In my own mind, however, I have come to certain conclusions so far as the policy for states in the north central region is concerned. They are as follows:

1. Growing-season inspection is essential in the case of many kinds of plants.
2. It can be enforced only at the source, not at destination.

3. It can be evidenced only by certificate tags attached before the stock is accepted for shipment by the transportation company.

4. States should either furnish such tags or should check on them annually to be sure they are correct.

5. If funds are available and competent personnel can be secured, an additional shipping point inspection is desirable with all tags being furnished and attached by the inspector.

6. When supplementary shipping point inspection is impracticable, more supervision at important distribution points en route is desirable and both the states and the federal department should increase the amount of work of this kind.

7. In some areas inspection at destination offers additional protection.

8. Even when inspection at destination is maintained, many trees and plants (including raspberries, currants, white pines, roses, elms, and maples) should not be accepted unless the bundle bears a tag evidencing prior growing-season inspection.

Mr. Warner: I want to comment on a point that was brought out by the gentleman from Canada. Their parcel post shipments of plants evidently will go to central points of inspection, and after inspection be sent postage free to destination. That isn't the case in the United States. The person who sends a very delicate plant has to also include postage from the central inspection point with which to send it to the destination point, and often the plant dies while you are trying to get the postage to help the person out. Was that right?

Mr. McLaine: Yes. It applies particularly to plants imported into the country, not shipments of plants that are forwarded from one point of the Dominion to another. It was an arrangement which was made after a good deal of deliberation between the Customs and the Post Office Departments. They finally agreed to do it.

Mr. Warner: It seems to me that is a weakness in our American laws at the present time. If we could arrange with the postal authorities to send them free to destination, there would be more plants inspected. As it is, the postmasters deliver them instead of sending them to inspection points.

Mr. McLaine: If the shipment of plants arrives at a point other than an inspection point, it has either to be destroyed or go to an inspection point for examination, in which case the consignee has to pay the postage both ways.

Mr. E. R. Sasscer: Dr. Fracker, in introducing his subject, remarked that he understood the Western Plant Quarantine Board was going to take certain action at their last meeting with respect to certificates, especially as applied to those packages. Such action was taken, and resolutions were sent to the Board following the meeting. For the benefit of those here, I am going to read the latter part of this resolution.

"Therefore, be it recommended, That the Federal Horticultural Board take up with the Secretary of Agriculture for recommendation to the Post Office Department that paragraph 2 of Section 467 of the Postal Laws and Regulations be so amended as to eliminate the broad certification requirement and make special provision for labeling plant or plant product parcels in order to reveal the exact nature of the contents, their origin, and the name and address of the sender."

For your further information, I am going to read Paragraph 2 of the Postal Regulations:

"Nursery stock, including all field-grown florists' stock, trees, shrubs, vines, cuttings, grafts, scions, buds, fruit pits and other seeds of fruit and ornamental trees or shrubs, and other plant products for propagation except field, vegetable, and flower seeds, bedding plants and other herbaceous plants, bulbs and roots, may be admitted to the mails only when accompanied with a certificate from a state or government inspector to the effect that the nursery or premises from which such nursery stock is shipped has been inspected within a year and found free from injurious insects and plant diseases, and the parcel containing such nursery stock is plainly marked to show the nature of the contents and the name and address of the sender."

The object of bringing this up at this time is to determine whether or not this organization desires to be placed on record on this subject. A brief summary indicates that thirty-three of the states now require certificates on all containers entering the state. There are eleven of the states which require that the containers bear a license tag, all of which would be eliminated if you carried out the suggestion contained in the resolution which I read a moment ago. States requiring certificates of fumigation include seven. There are now fourteen states exercising the right of terminal inspection.

It has occurred to me that perhaps it would be well before attempting to go on record to have a committee appointed to decide whether or not you want to make a similar recommendation.

Naturally in taking this action the Western Plant Quarantine Board had in mind many of these small shipments made by friends in exchange

of plants. We can perhaps safely say that fifty per cent of the postmasters are not aware of this regulation, or have forgotten it and accept plants.

CHAIRMAN HADLEY: Are there further comments?

Is it your thought, Mr. Sasscer, that this body should draw up and pass on certain definite recommendations along that line?

MR. SASSCER: It is not necessarily my thought. The Federal Horticultural Board has been requested by the Western Plant Quarantine Board to take the action referred to in the resolution. It occurred to me that those states represented here would like to consider this resolution from the standpoint of the effect it will have on their state regulations.

I don't believe that you could very well decide this in a few minutes, and it is my suggestion that you have a committee who would have an opportunity to go over the papers I have and report back this afternoon. Naturally the Board would like to have some idea as to the feeling of the states east of the Rockies with respect to this resolution.

MR. FRACKER: As indicated in the paper just read, I feel that such action on the part of the Post Office Department would be very unfortunate. In our state even where inspection at destination is possible, many kinds of stock are not acceptable at the present time. I think it might be desirable for this body, if they wish, to consider that matter further, since the only communication now before the Federal Horticultural Board is the one from the Western Plant Quarantine Board requesting modification of the postal regulations along those lines.

MR. MONTGOMERY: It occurs to me that this matter possibly involves questions that are much more far-reaching than appear on the surface. I move that this matter be referred to the Regional Plant Quarantine Boards for their consideration, and referred later to the National Plant Quarantine Board.

CHAIRMAN HADLEY: The motion, as I understand it, is that this matter be referred to the Regional Plant Quarantine Boards for their consideration, and referred later to the National Board. Is there any discussion?

The motion was voted upon and carried.

MR. FAXON: Another question that has come up quite a number of times with us is in regard to what constitutes an altered certificate. A good many of our nurserymen like to have their certificates printed in large numbers on account of the cheapness and have a good many of them left over from one season to another, and according to our attorney

general, if they cross out the old number and the old date and insert the new number and new date, that would not be considered an altered certificate. I am wondering how many states would accept certificates that had been changed in ink by a nurseryman.

CHAIRMAN HADLEY: I might say in the case of Pennsylvania we have ruled that changing the date of the printed certificate constitutes alteration. That has never been taken up directly with the attorney general; we ruled arbitrarily that the printed certificate changed as to date or anything else rendered it invalid, and told them to act accordingly.

MR. MAX P. ZAPPE: I think the nurserymen in Connecticut get around that by leaving the space blank on their printed certificates and simply writing in with ink the number of the certificate and the date that it expires.

MR. DEAN: If a number is crossed out or erased and another number put in, we consider that invalid.

CHAIRMAN HADLEY: Is there any further discussion? If not, we will go on with the next paper on the program by C. W. Stockwell.

THE INSPECTION OF VEHICULAR TRAFFIC AS PRACTICED IN THE ENFORCEMENT OF THE JAPANESE BEETLE QUARANTINE[1]

By C. W. STOCKWELL

ABSTRACT

The effectiveness of the Japanese beetle, (*Popillia japonica*) Quarantine depends largely upon the establishment of a force of uniformed road inspectors maintained at the outer boundary of the Quarantined Area to inspect traffic for certified and uncertified shipments of restricted articles.

The effective enforcement of the Japanese Beetle Quarantine depends largely upon the amount of check-up made on the movement of restricted articles from the regulated area. The methods of transportation used to move the various types of products are many, but the purpose of this paper is to discuss only methods of inspection as applying to traffic over the highways.

The Japanese Beetle Quarantine prohibits the movement from the regulated area of nursery and greenhouse stock, sand, soil, earth, peat, compost and manure, throughout the year, and certain farm products between June 15 and October 15, unless certified for shipment. Included within the area are hundreds of nursery and greenhouse establishments growing large quantities of nursery and greenhouse stock; also thousands of farms growing produce for distribution to points

[1]Contribution No. 21 Japanese Beetle Laboratory.

beyond the regulated zone. The greatest movement is during the summer months when farm produce is being transported to outside markets by truck loads and smaller quantities are carried by individuals in private automobiles. Nursery stock is carried in varying quantities at any time during the spring, summer or fall.

In order that the public may be adequately informed as to the limits of the restricted area, conspicuous signs have been placed on each road leading from the area, stating that the transporting of certain products beyond that point is prohibited unless certified by the Department of Agriculture. In addition to these signs, it has been customary to station road inspectors on the principal highways at the quarantine line to inspect traffic moving out. Due to the difference in laws in the States it has not been advisable to enforce regulations for the stopping of traffic uniformly in all States, but in general the instructions to road inspectors have been to stop all trucks and such pleasure vehicles as show evidence of carrying quarantined articles. If it were permissible to stop all traffic, it would be impossible on certain highways near large cities due to the immense volume of traffic. At one inspection point on Sunday nights, automobiles pass at the rate of 2,400 per hour. An attempt to interfere with the free movement of this traffic would immediately cause a tie-up. Trucks, however, are required to follow the outside line, where they may be stopped.

The inspectors are on duty and posts are covered for varying lengths of time, depending on the importance of the various roads. It has always been the policy to cover the main trunk roads for the longest periods of time, some of which roads are patrolled 24 hours a day, the inspectors being on duty for 8-hour shifts. In some localities the roads are covered but 16 hours a day, the inspectors being on duty during the hours when most traffic is moving. On still other less important roads but one inspector is placed, and only then during the hours of heaviest traffic movement. In Pennsylvania for the past two years a different method of operation has been in use. In that State the inspectors have been supplied with Ford roadsters, the territory divided into districts and each inspector assigned certain roads to patrol, spending most of his time on those most important, but frequently visiting back roads to check up on traffic there. All inspectors are under the supervision of district supervisors, whose duty it is to visit each man at least one or more times daily. These supervisors being in daily touch with the men are able to keep them fully advised as to any changes in regulations, or any matters upon which they are to be particularly alert.

Supervisors also visit the men at irregular intervals, and do not follow a daily schedule.

Previous to 1926, only a small portion of the road inspectors were uniformed, but during the past season all inspectors on the roads wore uniforms consisting of oxford gray whipcord breeches, gray shirt, black tie, puttees and shoes, and uniform cap with badge. This outfit was considered regulation and all men were required to wear it while on duty. This uniform did much toward gaining the respect of the travelling public, as all the men looked well in their uniforms and were a credit to the service. The results gained and the favorable comments from outsiders coming in contact with the road inspectors were sufficient to warrant the continuance of the uniformed inspector.

Some of the important quarantine posts were located at isolated points on the roads and it was necessary to supply lights at night. This was done either by connection with local service lines for electric light, or by use of carbide lamps. The electric illumination is much more satisfactory, as more light can be obtained. At the two most important inspection stations in New Jersey, large electrically-lighted signs were used, and in addition three large lights with proper reflectors to light the roadway at the point where traffic was stopped. Also at these points booths were placed for the use of the inspectors. At each of these two stations an average of from 75 to 100 trucks carrying farm produce were stopped each night throughout the summer season. As each truck was stopped, inspectors made a record of the certificate, checking the load carried with the amounts recorded on the certificate, also looking for alterations and void certificates. If everything apparently checked satisfactorily, the truck was allowed to proceed, if not, the load was refused movement out of the area. Occasionally truckers proceeded after being notified regarding quarantine regulations, in which cases they were usually taken before the local magistrate and fined. During the season of 1926, fewer violations occurred than previously, due to more cooperation of the State Police and the knowledge of the numerous fines imposed the previous season. No trouble was had with the larger truckers or growers, as they invariably complied with the regulations, but occasionally those less well informed, including foreigners and others but recently included within the extended area, would attempt to get by without certification. In New Jersey during the season of 1926, approximately 10,000 truck loads of produce were investigated at the quarantine line, the few found without certification were turned back and directed to an inspection point established within the quarantined area.

The State Police have been very helpful in the prosecution of the work, particularly in Pennsylvania, where 10 to 15 State Troopers have been assigned to the work with Japanese Beetle road inspectors each summer. The State Police were assigned to work with the inspectors on night duty patrolling the principal highways in the vicinity of the quarantine line.

In the past it has not been possible to continue the road inspectors over as long a period as desirable, although plans for the coming year anticipate the development of a permanent force for this particular phase of the work. With such an organization operating continuously at the limits of the quarantined area it is believed that greater efficiency of the quarantine might be gained.

MR. STOCKWELL: The government does not supply the uniforms. The men are required to buy their own uniforms. The uniforms used this season were not very expensive; they ranged around ten to fourteen dollars. We supply the caps, but the rest of the uniform is supplied by the individual.

MR. MONTGOMERY: Are the inspectors vested with police power, to search, seize and arrest?

MR. STOCKWELL: The inspectors have no police power. In Pennsylvania where they work with the police, the police of course would take the violator before a magistrate. The inspectors can do that as well. If there is any violation the case is taken into court later on.

MR. MONTGOMERY: The inspector cannot himself issue the summons to appear in court.

MR. STOCKWELL: No. We have very good cooperation in New Jersey and Pennsylvania with the state police, and on the principal roads which are near police headquarters, we are able to get police on very short notice. Occasionally if a man insists on moving out of the area, the police head him off before he goes many miles and bring him back. That has been done a number of times.

DR. MARLATT: Mr. Chairman, in Pennsylvania do your state inspectors have power to arrest and hold in a case of that kind, or must you appeal to the state police?

CHAIRMAN HADLEY: Under our Pennsylvania law, our inspectors have the right to stop all kinds of vehicles for inspection, but not to make actual arrest. However, our working arrangement with the police is very nice in that the state police have power of arrest for violation of any act or regulation, but do not have the right to stop for inspection

unless on a clearly apparent cause. By working the two of them, we give the state policemen actual connection with the department as a deputy inspector of the Department of Agriculture, which gives him the authority to stop any type of vehicle for inspection on suspicion. You know you can suspect anything you want to, which is the beauty of that law. But on the contrary the state police do not give our own inspectors the right to make arrest. In that case, the inspector must go to the nearest magistrate and have a warrant sworn out which can then be served by a state policeman or any other police officer, county detective, or any other type of officer.

DR. MARLATT: Are the Federal inspectors given state powers in Pennsylvania?

CHAIRMAN HADLEY: Yes. The Federal inspectors on the Federal payroll are given specific status on the state department, furnished with a badge and a card of identification certifying that they are engaged in duties under the supervision of the Department of Agriculture.

The state police are used largely at night and on some of the more heavily congested roads. Very few people fail to stop during the day-time on signal of our inspectors. The state police department pays the men's salaries and our department pays the other operating expenses, furnishing the machines, and so on.

We will go to the next paper under this subject, by L. H. Worthley.

INSPECTION OF VEHICULAR TRAFFIC IN ENFORCEMENT OF THE EUROPEAN CORN BORER QUARANTINE

By L. H. WORTHLEY, *Administrator in Corn Borer Control, U. S. Bureau of Entomology*

Federal Quarantine No. 43, on account of the European corn borer, regulating interstate movements of quarantined products, and State quarantines regulating intrastate shipments within the areas infested, are being enforced to prevent further spread into non-infested areas. Enforcement has been directed by the Federal Hoticultural Board and the United States Bureau of Entomology, in cooperation with the various States.

The possible spread of the pest through artificial means is an important factor. All vehicles leaving the quarantined areas are stopped at the border. Inspection of this vehicular traffic varies in its operation. The passenger-carrying automobile is the vehicle most concerned in this inspection work. The following types of vehicles also are included: auto-trucks and horse-drawn wagons. Steamboats and river-boats also constitute great possible agencies for spreading infestation.

The greatest amount of attention to vehicular traffic inspection was given at the quarantine lines in Pennsylvania, Ohio, and Michigan, our objective being to prevent long-distance spread. Results indicate the work as being important, necessary and effective.

Uniformed inspectors were stationed on all roads leading from infested to non-infested areas, all outward-bound vehicles being stopped and searched for ears of green corn, stalks, etc. As a means of attracting the attention of all drivers, road banners, quarantine signs, stop signals, lanterns, flashlights, and high-powered carbide lights were used. This work was conducted for twenty-four hours each day during the sweet-corn season. On the most important main roads a three-shift force was maintained. Army tents were provided for inspectors, who camped on the spot. In addition to these inspectors, assistance was rendered by state motor-cycle officers and constabulary officers. These officers were shifted on short notice to patrol back roads and intercept hucksters and others who might attempt to avoid the inspectors stationed on the main highways.

In 1926 forty quarantine lines were operated on the roads bordering the quarantined area in Ohio and six additional interstate lines were conducted at the Ohio-Indiana State boundary. Forty lines were operated in Michigan and ten lines in Pennsylvania.

Quarantine lines have been operated during the past four seasons in the middle western territory and, during the last two seasons, have been generally accepted by the traveling public as necessary and important, the inspectors experiencing but little trouble in enforcing regulations. In Ohio, during the 1926 season, with approximately one million automobiles stopped, only 429 refused to obey the inspector's signal, and these machines probably were engaged in some unlawful enterprise. Out of a total of 800,000 machines stopped in Michigan, 754 refused to respond to signals. In Pennsylvania 341,888 cars were stopped and only 116 similar violations occurred.

In the New England area during the present season, i. e., from June 1 to December 15, the following farm products were permitted and certified at Boston, Mass., for shipment to points outside the quarantined area, viz: 15,793 bushel boxes of green beans, 5,568 bushels of bunch beets, 22,831 bushels of celery, 618 bushels of rhubarb, and also 1,861 bushels of green corn on cob which was grown outside the infested area, making a total of 46,671 bushels of farm products. During the same period the following cut flowers were inspected and certified at Boston for shipment to points throughout the United States, viz: 98,994 asters,

265,476 chrysanthemums, 1,022 cosmos, 344 dahlias, 89,763 gladioli, 18 hollyhocks, and 1,891 zinnias, making a total of 457,498 cut flowers grown in the infested area.

These shipments went by rail, by water and over the highways in long-distance trucks. The railroad companies, steamship lines and express companies have shown a sincere desire to cooperate with the government in enforcing the quarantine regulations, but, unfortunately, no such friendly spirit of cooperation has been in evidence with the automobile trucking concerns. The shipment of farm produce from the Boston wholesale district to northern Maine, New Hampshire, Vermont, New York, western Massachusetts and northern Rhode Island and Connecticut, by long-distance covered trucks has increased tremendously in recent years and this method of shipment affords the easiest means of evading the quarantine regulations and the hardest problem of the inspectors, whose duty it is to see that no quarantined products are carried from within to points outside the infested area without permit or certificate.

The various State plant quarantine acts have been drawn along similar lines in all respects but the authority conferred by the General Laws, under which these acts were promulgated, varies considerably; consequently there is more or less variance in the methods of dealing with violators. Cases which are pigeonholed or held pending in the courts of justice lose their force and good effect.

Adequate Federal and State legislation to enable and provide strict enforcement of the law so as to bring violators to immediate trial and conviction in local courts is absolutely necessary to the efficient enforcement of quarantine regulations. The best present example of such cooperation is that now existing with the State of Pennsylvania where, during the past season, out of a total of 116 intentional violations, 114 of the offenders were immediately tried and convicted.

While the stopping and examining of vehicles has been fairly successful the past two or three seasons, considerable publicity has been given through the medium of middle western newspapers to the fact that we have been operating on "bluff." The one exception to this condition is Pennsylvania, where adequate regulations are in force with the exception of the desirable provision to confiscate contraband material and destroy the same. It is anticipated that next season, with the knowledge the public has gained through the unfavorable publicity, inspection at quarantine lines will be greatly handicapped as the public probably will demand its rights under the present law in this matter.

The present regulations therefore should be reinforced by additional Federal and State legislation. It has been suggested to the States concerned that a Special Act containing adequate authority be passed by their legislatures to enable regulatory officials to do this work in a legitimate manner.

The following figures summarize the work on quarantine lines in the States of Ohio (1922 to 1926, inc.) and Pennsylvania and Michigan (1925–1926):

Total number machines stopped	6,491,491
Number refusing to stop	6,743
Ears of corn taken	403,469
Number of European corn borers in seized corn	5,591

MR. WOOD: Mr. Chairman, I would like to ask Mr. Worthley if he has any data indicating where the machines were going that were stopped. How far would they have gone outside the corn borer region?

MR. WORTHLEY: In 1925 I believe we stopped 300 machines that were going more than 100 miles, and this year we stopped three machines going to Iowa. We stopped two that were going to Florida. One of them was carrying "corn on ice," and intended to renew it on the way down. Surely hundreds of them were going into Illinois and parts of southern Indiana and into Kentucky.

DR. MARLATT: I find there is no place in the Association program for a discussion of large subjects of interest to many of us here, namely, the corn borer quarantine and its operation and outlook and the Japanese beetle quarantine. I wonder if that is provided for in any programs that are to follow. If not, it might be a good plan to open up those subjects for an informal discussion later in the day. I am speaking now purely of the quarantine and control side.

MR. A. F. BURGESS: I didn't hear quite all that Dr. Marlatt said. I would like to say just a few words in connection with the gipsy moth quarantine which has been in operation practically since the Federal Horticultural Board was established, that is, the general operation officially. Prior to that time it was an informal quarantine made by arrangements with the railroads and common carriers. At one time when the brown tail moth was very abundant in eastern Massachusetts, arrangements were made with the railroads to inspect the through trains, because it was found that the moths were being carried to some extent, particularly on the engines around the headlights and in the Pullman cars when bright lights were present.

These inspections were made by arrangement with the railroads at points en route where engines were changed and the trains were held up for a few minutes. Later on inspection was made in cooperation with the railroads, of the products that were shipped out of the infested territory.

After the Plant Quarantine Act was passed and the gypsy moth quarantine was enacted by the Federal Horticultural Board, most of the quarantine activities were taken care of under those provisions. We have, though, from time to time, done a certain amount of road inspection where there seemed to be danger of material going out on vehicles. During the past few years we have done some road inspection, particularly in connection with the shipment of Christmas trees from the quarantined area to points immediately outside, where those trees might be carried by trucks or by tourists or others who were going a short distance.

We have in that work encountered very little opposition from the public. When trees were found on vehicles that were stopped, the owner had the option of leaving the trees or of taking them back inside of the quarantined border, if the station was outside of the border, and having them inspected and certified before they passed on.

Your Secretary asked me to prepare a paper in connection with this matter, but owing to the fact that there seems to be so little legal authority for doing this work, it seemed to me results could be accomplished better by conference than by giving too much publicity to the weakness of the legal phase of this operation. I understand, however, that the subject has been discussed quite freely in some sections in the press, and it seems to me there is urgent need that inspectors have more authority to stop vehicles and make inspections.

I hope very sincerely that some action will be taken as the result of this group meeting here at this time to assist in bringing about this most needed legislation, not for the states but for the Federal Government.

MR. WORTHLEY: In addition to that I might say a corn borer conference was held in Detroit the latter part of September, and it was brought out there by one of those attending that we are operating our quarantine lines entirely on bluff. That was immediately taken up by the Chicago Tribune and from the Tribune it went to 250 newspapers in the Middle West, so that it got an excellent amount of publicity. By another season we must have something else.

CHAIRMAN HADLEY: I might say with reference to Dr. Marlatt's suggestion, which I think is very good, that we are pretty well along on the program and we may have opportunity to bring up some other questions which are perhaps of more general interest.

Tuesday Afternoon, December 28, 1926

The meeting convened at one-fifty o'clock, Dr. S. B. Fracker presiding.

CHAIRMAN S. B. FRACKER: Mr. Hadley has asked me to substitute for him this afternoon, and as it is already past time, we will begin now. The first paper is by Mr. Warner.

FLORIDA QUARANTINE—AMERICA'S PROTECTION AGAINST PLANT PESTS OF THE AMERICAN TROPICS

By L. R. WARNER

(Withdrawn for publication elsewhere)

DR. C. L. MARLATT: I was very much interested in hearing this paper. I want to express again the appreciation which the Department of Agriculture feels, which we all feel, for the service which Florida and California are rendering in protecting the United States against these pests, a service which has a value that cannot be estimated in dollars, or at least it would run into war figures very rapidly. It is a service that we are making the utmost use of—the protection of the ports of Florida and California is entirely done by these two states and the Federal Government is relieved from any responsibility or at least from any expenditure for work in connection with that service. I say relieved from any expenditures; we do have State officials commissioned as collaborators of the Department of Agriculture and give them the authority of officers of the Department in the enforcement of Federal quarantines and pay them, but their stipends are merely nominal and it is a tremendously valuable service.

There is no question that the protection by these two rather strategic states is on a much higher plane than it is anywhere else in the United States.

DR. WILMON NEWELL: Mr. Warner spoke of the fact that very much material was brought in from foreign countries without any intention of violating the law. That is probably true. The quarantine and customs inspectors, of course, have such a large number of people to deal with and have such a tremendous task upon their hands that they depend very largely upon their estimate of human nature in their

inspection work, but it is not true that because a man is posted on the laws of the country that he is willing to abide by the laws of that country.

I was somewhat dumbfounded not very long ago to find that the dean of a law college in a well-known university of this country smuggled in through Key West a living plant from a black-fly-infested territory. He successfully got by the customs inspectors and quarantine inspectors, took that plant home and planted it in his own home town.

There, is an example of a man who knew the law and knew he was breaking the laws of his country, a man who certainly must have known some of the danger attached to doing that particular thing, and because he was intelligent and apparently a man of means and a man of consequence, the inspectors perhaps didn't go quite as far into his baggage as they would into the baggage of some person of lower intelligence. There, is the person who smuggles for the purpose of trying to defeat the laws of his own country. Perhaps some of you who are engaged in quarantine work will want to bear this particular instance in mind because there is a factor which is very hard to deal with.

DR. C. L. MARLATT: Mr. Chairman, as I have seen the state inspectors working, I think they do the work regardless of the importance of the individual. I have had a number of distinguished gentlemen who crossed the Pacific from Honolulu, come back and report to me that they were stopped and their baggage gone through with a finetoothed comb—members of Congress, and others. I have yet to find any of them who objected to it. They were glad to see it.

I have a great deal of confidence that these men in Florida and California as well as our own men, are doing their work regardless of persons.

MR. MAX KISLIUK: In regard to letting certain officials and well-known characters get by, I know from personal experience that very often an official of some foreign government or a prominent citizen of this country who may be coming back from abroad may get a courtesy of port by letter to the collector of customs. The collector of customs will forward it to the boarding officer, who is the first customs officer to approach a ship, and from the boarding officer it will go down the line to the inspector at the dock, all granting this particular individual or individuals the courtesy of the port. As far as my experience goes with this courtesy of port, there is very little inspection of baggage. If they have any suspicions, they may open one or two bags or a trunk, but they do not go through it as thoroughly as they would with an ordinary citizen.

Dr. C. L. Marlatt: I know there are difficulties of that type, and especially in the army and navy. We have had to take up several cases with the Secretary of the Navy who has given us absolutely full support. We have had similar difficulty with army transports. I have one case on my desk now that we are going to take up with the Secretary of War. As a rule, we can get proper explanation or adequate support as far as the Secretary is concerned.

I may have told you of an incident indicating the lack of weight given to persons in power. A shipment to the wife of the President of the United States was held. It came through diplomatic channels. An inquiry was made about it from the State Department and a report made that such plants for personal use were not allowed to come into the United States. We could not make exceptions for any citizen. The State Department said we were quite right and we would never hear anything more about it. I met the private secretary of the President's wife a month or two afterwards. I happened to mention this incident. "Ah," she said, "we had a letter about those things. We have been looking for them ever since. We didn't know what became of them."

Chairman S. B. Fracker: If there is no further discussion, the next paper is by A. G. Ruggles and J. D. Winter.

RESULTS OF THREE YEARS' EXPERIENCE IN THE CONTROL OF MOSAIC IN RED RASPBERRIES IN NURSERIES

By A. G. Ruggles and J. D. Winter, *St. Paul, Minnesota*

Abstract

Roguing for the control of mosaic in red raspberry plantings has been carried on by the Minnesota nursery inspection service for the past three years. Approximately 125 acres were inspected and rogued in 1925 and about 175 acres in 1926. Each individual bush was inspected two or more times each year. Very careful counts were made during the roguing operations. The data obtained show that the amount of mosaic is steadily decreasing. Even with those varieties in which mosaic was most prevalent in 1923 the disease has been reduced to a very low percentage. A number of plantings now appear to be entirely free from infection. Roguing for the control of mosaic in red raspberry plantings seems to be entirely practicable.

Last year before this section we presented a paper on the control of mosaic in plantings of the red raspberry. In this paper four conclusions were given, namely (1) that mosaic can be effectively controlled by roguing (2) that isolation from nearby sources of infection is essential in control (3) that detection of the very early stages of mosaic is necessary in control (4) that mosaic as diagnosed under standards of inspection in Minnesota is definitely systemic. These conclusions were reached

from the study of data obtained during 1924 and 1925. It seems proper at this time to present further data on the control of mosaic by roguing obtained through studies which continued during the season of 1926. It does not appear necessary to give further data concerning the other conclusions which were reached as a result of the work during 1924 and 1925.

It became apparent early in the course of work during 1926 that very definite progress had been made in control of mosaic in the raspberry plantings. The data obtained show a consistent reduction in the percentage of mosaic. A number of plantings from which a small amount of mosaic had been rogued in 1925 appeared to remain entirely free from mosaic throughout the season of 1926. In the majority of the other rogued plantings mosaic apparently is approaching the vanishing point.

As in previous years uniform methods were employed in computing the percentage of mosaic present in each planting. Mechanical counters were used in connection with the roguing to reduce the possibility of errors. All computations were based on the number of hills originally planted.

One important change in roguing methods was made in 1926. This was brought about by an unexpected increase of mosaic in four Latham plantings which had been very carefully rogued in 1925. The amount of mosaic found in 1926 in these four plantings averaged only 4.9%, but this amount was unusual in plantings which had been so carefully rogued the previous year. It was very obvious that this spread had occurred principally around the places where one or more diseased bushes had been taken out in 1925. Reference to the records showed that aphids had been abundant in these plantings at the time of the roguing. Naturally the evidence indicated that this unusual spread might have occurred by disturbing the aphids on the infected plants so that they had carried infection to nearby bushes. Therefore, during the season of 1926 wherever aphids were found abundant the infected bushes were burned where they stood before roguing was attempted in order to destroy the aphids. This was usually accomplished by using a small hand sprayer and kerosene. This method also had the advantage of effectively marking all bushes to be rogued so that they could be dug out at any convenient time soon after. In this way it is believed that the possibility of spreading infection at the time of roguing is greatly reduced.

Approximately 175 acres of raspberry plantings in Minnesota nurseries are being inspected at the present time. For the most part these plantings are being grown for the production of plants with fruit production of secondary importance. About 127 acres consist of the Latham variety. This acreage is distributed throughout the state in 136 separate plantings.

The following tables are presented to show the progress which has been made in reduction of mosaic in inspected plantings of the Latham variety during the past three years. The records for this variety were chosen because the Latham is the principal variety of the red raspberry grown in Minnesota. Similar results have been obtained with fourteen other varieties. The red raspberry is grown quite extensively in Minnesota, but commercial plantings of the black raspberry are rare. Control work therefore has been confined largely to the red varieties.

TABLE No. 1. LATHAM PLANTINGS ROGUED 1924 TO 1926—PLANTINGS MORE THAN ONE YEAR OLD

	Number of Plantings	Approx No. of Acres	Total Hills Rogued	Av. Percent of Mosaic
Rogued in 1924				
Plantings not previously rogued	33	24	3,168	6.6%
Rogued in 1925				
Plantings previously rogued	32	21	1,956	4.6%
Plantings not previously rogued	0			
Rogued in 1926				
Plantings previously rogued	83	88	2,629	1.4%
Plantings not previously rogued	5	2	172	4.9%

TABLE No. 2. LATHAM PLANTINGS ROGUED 1924 TO 1926—PLANTINGS LESS THAN ONE YEAR OLD

	Number of Plantings	Approx. No. of Acres	Total Hills Rogued	Av. Percent of Mosaic
Rogued in 1924				
Plants from selected unrogued plantings	15	10	records not complete	
Rogued in 1925				
Plants from rogued plantings	67	66	6,316	3.8%
Plants from selected unrogued plantings	23	12	4,865	15.4%
Rogued in 1926				
Plants from rogued plantings	43	32	1,010	1.5%
Plants from selected unrogued plantings	5	5	973	9.9%

Table No. 1 shows that an average of 6.6 per cent mosaic was rogued from 33 plantings which were selected in 1924 as the best foundation stock available for general planting. For this purpose roguing was not

attempted in plantings where more than fifteen per cent mosaic was found.

The following year, 1925, an average of 4.6 per cent mosaic was found and rogued from 32 plantings more than one year old. These plantings included 17 of the original 33 plantings and the 15 plantings which were planted in 1924 as shown in Table 2. Complete records were not kept in 1924 for all the plantings established that year, but in some instances as much as 25 percent mosaic was rogued.

In 1925 isolation from nearby infected plantings was required as a condition for certification. This was not required in 1924. Therefore, many of the plantings certified that first year could not be certified again.

The reduction of mosaic in 1925 as shown by inspection records for 1926 is very marked. It is particularly interesting to note that the amount of mosaic found in 1926 in the older rogued plantings, namely 1.4 per cent, was substantially the same as found in the new plantings of 1926 established with plants from rogued fields. The amount of mosaic in these new plantings averaged 1.5 per cent.

TABLE NO. 3. TOTAL LATHAM PLANTINGS ROGUED 1924 TO 1926

	Number of Plantings	Approx. No. of Acres	Total Hills Rogued	Av. Percent of Mosaic
Rogued in 1924				
Not previously rogued	48	34	records not complete	
Rogued in 1925				
Previously rogued	99	87	8,272	4.0%
Not previously rogued	23	12	4,865	15.4%
Rogued in 1926				
Previously rogued	126	120	3,639	1.4%
Not previously rogued	10	7	1,145	8.5%

Table No. 3 is a summary of Tables No. 1 and No. 2. The average amount of mosaic found in all Latham plantings in 1925 was 5.5 per cent. This figure is not shown in the table but is the weighted average for the two figures given, namely 4.0 per cent and 15.4 per cent. The reduction of mosaic during 1925 is therefore from 5.5 per cent to 1.4 per cent. These figures assume added significance when it is noted that during 1926 only seven plantings failed to pass inspection out of a total of 133 plantings of previously rogued stock. The inspection records for 1927 will indicate what actually has been accomplished during the inspection season of 1926.

Control Methods Recommended

As a result of three years experience in roguing the following methods are recommended for the control of mosaic in nursery plantings of the red raspberry under Minnesota conditions:—

1. Careful inspection for diseased plants should be given by the owner once each month during June, July, August and September. In addition two official inspections should be made each year, the first between June 1 and July 15 and the second between July 15 and September 15. The two official inspections should be made not less than 30 days apart.

2. When an infected bush is found it should be dug at once including all the roots and sucker plants. If aphids are present the bush should be burned where it stands, before digging, to destroy the aphids and other insects. A hand sprayer with kerosene is useful for this purpose. If the planting is more than three to four months old the bushes standing next in the row, if within three feet, should be removed in the same manner. It is advisable to place a stake at each place where a diseased plant has been removed so that sprouts can be looked for and destroyed in case the first digging failed to get all the roots.

3. It is usually not practicable to attempt the roguing of any planting more than one year old in which more than 5 per cent mosaic is found.

4. Mosaic free planting stock usually cannot be grown successfully if infected raspberry plants, either cultivated or wild, are growing nearby. Observations indicate that a separation of not less than 20 rods is necessary. This is the minimum distance required in Minnesota as a condition for certification of any raspberry planting. A greater distance is always preferable where this is possible.

5. When a new planting is started for the production of plants it is advisable to obtain stock from a planting which has been given competent inspection and roguing for not less than two successive years. Plantings in which more than 2 per cent mosaic has been found during the year the plants are dug should not be used as a source of stock for propagation if better plants are available.

6. In selecting a planting site observations indicate that an open or exposed upland location is the more desirable as aphids are usually more numerous in sheltered and secluded places. It is possible that the use of a contact insecticide for spraying at regular intervals during the growing season may sufficiently reduce the number of insects so that the spread of mosaic would be materially retarded. Spraying for

this purpose has not been practiced in Minnesota and it is not certain whether this treatment would be of sufficient value to justify the expense.

CONCLUSION

Evidence continues to accumulate showing that the control of mosaic by roguing in nursery plantings of the red raspberry is practicable.

CHAIRMAN S. B. FRACKER: If there is no discussion on this paper, the next item on the program is Reports of Committees. I am informed by the Secretary that under that heading properly comes the reports of the Regional Boards. I will ask Dr. Headlee to report on the work of the Plant Conference Board of the Middle Atlantic and North Eastern States. [The report has not been submitted for publications.]

CHAIRMAN S. B. FRACKER: Are there any questions on this subject? If not, we will hear from Mr. Glenn, representing the Central State Advisory Plant Board.

Mr. P. A. Glenn reported for the Central State Advisory Plant Board.

CHAIRMAN S. B. FRACKER: Are there any comments? If not, we will hear from Dr. Newell on the work of the Southern Plant Quarantine Board.

DR. NEWELL: "Professor Harned, who is Chairman of the Southern Plant Quarantine Board, is attending another meeting just at this time, but before leaving the room asked me to report, for him, on this matter.

"The southern regional board was organized at Atlanta last February. Professor R. W. Harned, of Mississippi, was elected Chairman, Mr. W. E. Anderson, of Louisiana, Vice-Chairman, and Mr. B. P. Livingston, of Alabama, was made Secretary. A constitution was adopted and Mr. George C. Becker and myself were designated as representatives on the National Plant Board. Later, following Mr. Becker's resignation, the executive committee of the regional board selected Mr. R. W. McDonald, of Texas, to serve as representative on the national body.

"The southern regional board has concentrated its efforts primarily on the task of harmonizing, as far as possible, the state regulations in the southern states and to this end has a very active committee at work on this problem, this committee consisting of Dr. J. H. Montgomery of Florida, Mr. H. J. De LaParelle of Georgia and Mr. George F. Arnold of Mississippi. This committee will submit its report at the next meeting of the Southern Plant Quarantine Board, which will be held at Atlanta about February 1st."

CHAIRMAN S. B. FRACKER: We will ask Mr. List to report for the Western Plant Quarantine Board.

WESTERN PLANT QUARANTINE BOARD

The Western Plant Quarantine Board held its annual meeting for 1926, at Olympia, Washington, from June 9 to 11. The officers elected for the ensuing year were as follows: President, Dr. Oscar C. Bartlett, State Entomologist, Phoenix, Arizona; Vice President, Mr. Geo. G. Schweis, Deputy State Quarantine Officer, Reno, Nevada; Secretary, Mr. W. C. Jacobsen, State Department of Agriculture, Sacramento, California.

The members on the plant advisory board are M. L. Dean, Boise, Idaho, and Lee A. Strong, Sacramento, California.

The relation of the recent Supreme Court decision to the plant inspection and quarantine work of the West came in for considerable discussion. It is felt advisable for most of the western states to reenact their basic laws. A movement was started to make these as uniform as conditions will permit when they are reenacted, and the executive committee has drawn up certain suggestions that should be worked into as many of these laws as possible. The effort to make all regulations issued on any one subject as near uniform as local conditions will permit, is being continued.

GEORGE M. LIST

CHAIRMAN S. B. FRACKER: The next subject on the program is the report of the Nominating Committee.

MR. J. E. GRAF: Your Committee on Nominations submits the following names for this Section: Chairman, Dr. J. H. Montgomery; Secretary. W. B. Wood.

CHAIRMAN S. B. FRACKER: This report is before you for consideration. What action will be taken?

It was moved and seconded that the report be adopted and the men named be elected. The motion was carried.

CHAIRMAN S. B. FRACKER: That completes the program, with the exception of the conference that was proposed this morning on the various regulations and quarantines of the Federal Horticultural Board. I think Dr. Marlatt should act as chairman of such a conference. If there is no other business to come before this group, I will turn the meeting over to Dr. Marlatt and ask him to act as Chairman of the conference at this time.

Dr. C. L. Marlatt: As I indicated this morning, I feel that this body each year should include in its program some sort of review of the important quarantine subjects which are being worked on in this country with the Federal Government and states cooperating. They represent the job of all of us and they are the big points of interest. We may discuss some of these details, but we should have each year a sort of round-up on the essential progress, the essential status of big projects—I mean the moth project under Mr. Burgess, the corn borer project which has its field direction in Mr. Worthley, and the Japanese beetle project with Mr. Smith in charge, and perhaps the pink boll worm project which is of interest to all of our southern members, and the related project of the Thurberia weevil, which has come up more recently.

These are all matters which affect large interests of the country and should be a part of our program in the future. They are rather left out on this program and left out on the program of the Entomologists, and unless we have an opportunity like this to set the present situation before you, a half dozen of the most interesting subjects that the entomologists of this country are working on would go practically untouched.

A good deal of water has gone over the dam in connection with the corn borer. There are various propositions in the air and possibilities likely of accomplishment which should, it seems to me, be brought to the attention of all of us, because we are all interested. You will be called upon to cooperate in some way or other before long.

I don't see Mr. Worthley here. I wanted to call on him now to tell us about the corn borer, and then the other subjects will come along, Mr. Chairman, and when you come to the pink boll worm, I will be glad to give you a little epitome of that and perhaps of the Thurberia weevil.

Chairman S. B. Fracker: I take it that the subject for discussion, then, is the present status of the Japanese beetle, the Federal and state regulations for its control, and any suggestions or comments that the entomologists may have on the Japanese beetle regulations and the status of the work.

We should hear first from Mr. Smith, I believe.

Mr. L. B. Smith addressed the meeting on the Japanese beetle.

Chairman S. B. Fracker: The entire subject of the Japanese beetle regulations is now open for discussion by any who are interested in the subject.

DR. L. S. MCLAINE: I would like to ask Mr. Smith if it is going to be the policy this next summer in connection with a market such as New York to certify all the market produce, as has been done in the past, or will the packages be certified in some way before they leave the market to indicate that the system of packing is approved?

MR. SMITH, in the discussion which followed, stated that there would be a flat embargo on the movement of green beans and sweet corn from the New York market to outside points. He explained that the distributing business of the commission men had become quite local in contrast to what it was a few years before when they fed most of the western New York cities, as well as many of those in New England. For this reason the embargo on outgoing vegetables was to be preferred by all parties concerned rather than a system of inspection and certification.

It is not anticipated that the New York markets will become infested as did the Philadelphia market for a number of years, as it is a distance of forty miles to the nearest point where the Japanese beetle occurs in any numbers, which is much beyond their distance of flight.

Corn from New Jersey going to New York is shipped in bags which are not opened in the market, but are distributed to the small local markets from whence the corn goes to the hotels and general populace.

Nearly all fruit entering the New York market is graded. The ungraded fruit picked fresh from the trees and shipped in open baskets nearly all moves to the south and west, much of it going to the mining towns of Pennsylvania.

MR. WORTHLEY spoke at length on the operation of the European corn borer quarantine as it has been carried on since the work began. He discussed the methods employed in the past and pointed out that in spite of all that was done the spread of the insect had continued from year to year. Mention was made of the meetings held in Chicago on June 3, 1926, and in Detroit on September 25 to discuss the situation. As a result of these meetings which were attended largely by experiment station directors, secretaries of state and others having large interests in the "Corn Belt" an appropriation of $10,000,000 is to be requested of Congress to carry out a cleanup campaign on the edge of the infested area and beyond in an attempt to prevent the further spread of the insect.

Some of the difficulties encountered in enforcement of the quarantine were mentioned.

DR. C. L. MARLATT: If I may add a few words in supplementing what Mr. Worthley has said, I think he has put a very plain statement of the situation before you. I think he made it clear in the first place that this movement, this gigantic demonstration, experiment, came up from the states. This committee that he refers to is a committee representing the corn borer states. It is headed by Mr. Curtis of Iowa, Dean of the division of Agriculture and Director of the experiment station—and is a committee of western men representing big interests in the West, experiment station men, secretaries of agriculture, et cetera, who became impressed with the fact, as Mr. Worthley has pointed out, that the corn borer ought to be stopped, after having seen its work in Ontario and waking up to the situation for the first time, and that the government should do a good deal more than it was doing to stop the spread.

As Mr. Worthley said, their idea was a gigantic demonstration control plan which would show what could be done to stop the spread, the idea being to clean up the corn in all this western area, two million and a half acres perhaps; a strip from fifty to one hundred and twenty miles across that represents the western band of the spread of the insect, an area in which the insect now occurs in very limited numbers and where it is found with the greatest difficulty.

The thought was that if you could clear up the corn stubbles, the stalks and every part of the plant in the fall and winter so thoroughly that the corn borer population would be reduced to the lowest element, just by the amount of that reduction you would reduce the risk of spread. No one can deny that corn is the carrier of the insect in the West; it hasn't spread very much yet to other plants, practically not at all. Such a reduction of the corn would have the effect of reducing the corn borer population enormously, and that is the basis for the experiment. If the experiment works, it won't eradicate the borer as Mr. Worthley said, but if the experiment succeeds in reducing the abundance of the pest to the minimum, it may prevent spread or slow up spread so much that it will give protection to the great corn belt which is just now being reached, which will be worth the expenditure of $10,000,000. That is a financial question that it is up to Congress to settle, but this proposition came up endorsed by quite a number of leaders of these western states and it is still in their hands. It was presented to the Budget Committee and quite an appeal was made.

There is just one other point I want to mention in this connection and that is the question of reimbursement. It isn't a pleasant thing,

to consider the beginning of a policy of reimbursement for farm work, clean-up work which the farmer ought to do. I don't know what the original idea was because I wasn't in any of the early meetings. I have only met twice with the committee, and then for a short time. The thought is, as Mr. Worthley pointed out, that there will not be any reimbursement to the farmer for any normal, reasonable and usual farm work, but if he is required under state law to do work that is unusual, additional and above his ordinary work, in other words, if he has to assume considerable and heavy cost to carry out the program of this experiment, he has a right to be reimbursed for that additional labor. The work can be done either directly by the state and Federal Government employing men to do it, as we employed men and cleaned up in the cotton clean-up work of the South where the expense was entirely Federal expense, or it can be done by the farmers. We didn't reimburse farmers for the work in the South because we did it ourselves.

We can ask the farmer to do it, not only ask him but compel him to do it, tax him or go in and do it for him, putting a tax on the land to represent the amount. That is the scheme these men have in mind. If he does the work he has an equitable right, I think in a sense, to be paid for that extra work. It isn't reimbursement, it is being paid for work which he is forced to do which he wouldn't normally do. If it were merely subsidizing the farmer to get him to do his normal work, I don't think there would be a moment's consideration of the proposition.

Dr. T. J. Headlee: Suppose the scheme doesn't work out and the $10,000,000 experiment is a failure? What plan is there for taking care of such a situation?

Dr. C. L. Marlatt: That is entirely outside and unrelated to the quarantine control work which is being done under Federal appropriation. It doesn't affect that work at all. That stands on its own feet. This appropriation, this gigantic demonstration experiment, will come to an actual and proper end if it demonstrates its futility. If it demonstrates any great utility, then it will be up for a subject to be properly considered as to its continuation. I put that question up to this committee myself and they were a little hazy on that point. Their idea seemed to be that if it worked, the results would be so large that it wouldn't need to be repeated, that the farmer himself would probably be able to take hold of that work and carry it on in the future. I think we all have reason to doubt that this would be done.

Chairman S. B. Fracker: Before going further on this I would suggest that we hear from Dr. McLaine on two phases that appeal to

me—the clean-up work that is being carried on and that will be carried on in Canada and the relation of the Dominion Government to the new shelled corn regulations.

MR. McLAINE: Replying to the chairman's questions with regard to what is being done in Ontario to control the European corn borer, and the danger of shipping shelled corn, it may be of interest to those present to review very briefly the situation as it stands today, although this matter will be discussed at greater length later in the week. During the past season the corn borer was found to have spread to sixty additional townships as compared to twenty-five in the previous year, and five in 1924. In Ontario it now covers approximately thirty-five thousand square miles. Outbreaks have also been found at two separate points in the province of Quebec, one of these is due to natural spread from Ontario, and the second to spread from New York State. The severely injured area, covering about four hundred square miles in southwestern Ontario in 1925, has now increased to twelve hundred square miles.

With regard to control, this matter is in the hands of the provincial and not the federal authorities, other than prevention of spread and quarantine enforcement. In 1925 the European Corn Borer Control Act was passed by the Ontario Parliament, the Act was amended at the 1926 session and in July of this same year regulations under the Act were promulgated. In accordance with this Act the Provincial Entomologist has authority to apply the regulations for controlling the pest to any county in which it exists, and to appoint inspectors to see that the control operations are being carried out. One-half of the salary and expenses of an inspector must be paid by the county or municipality in which he is working and the balance is paid by the provincial authorities. The regulations require that every person growing corn in the counties in which the corn borer act has been made effective, shall adopt such methods in the growing of corn, in handling the land and the remnants of the crop as will most effectively control the corn borer; the regulations further define just what action must be taken by the grower for controlling the borer. In the case of any grower, owner or occupant of any premises who refuses to comply with the regulations, the control work shall be carried out under the supervision of an inspector and the cost thereof shall be placed as a lien against the property, and be collected with the regular taxes. Provision is made for the penalizing of any individual who refuses to carry out the instructions of an inspector or who obstructs the inspector in the performance of his duty.

This act has been applied by the Provincial Entomologist, to eight of the most seriously infested counties of the province, and if the situation warrants it, the act will be extended to other counties next year.

With regard to the shipping of shelled corn, this matter has been carefully investigated and it would appear that there is but little if any danger in spreading the borer provided the corn has been thoroughly cleaned, but there is undoubtedly danger if the cleaning is not thorough and pieces of cob or other refuse are not removed. The question of certifying all shipments of cleaned shelled corn from the quarantined area is now receiving serious consideration.

DR. C. L. MARLATT: We couldn't do less than our friends across the line and in corn countries we have to require a certification of clean shelled corn as a condition of movement in the United States as well as a condition of movement between states.

DR. E. P. FELT: May I inquire why shelled corn is brought in under quarantine? Is it because it is not clean?

DR. C. L. MARLATT: The shelled corn frequently has a large percentage of cob in it and the corn borer has a habit of spending the winter in the cob.

Mr. Worthley, and men who have been in charge of the quarantine work, could tell you better than I. They have reached the conclusion that clean corn, that is, well cleaned, free from extraneous matter other than the clean grain, is practically safe as far as the corn borer is concerned, and the whole purpose of this inspection is to determine just that condition, that the corn is clean grain.

CHAIRMAN S. B. FRACKER: The entire subject of the corn borer is now open for discussion.

DR. C. J. DRAKE: We have been very much concerned over certain territory not included in the Federal quarantine, in the infestation in Long Island and in Connecticut and Staten Island. About two years ago we received a carload of corn on the cob from southern Connecticut, from near infested territory. I knew nothing about this shipment until after it had landed. It seems that Newark heard about the infestation in Connecticut and called the county agent. I would like to ask Mr. Worthley how long certain territory has been infested in southern Connecticut, Long Island, and New Jersey.

MR. L. H. WORTHLEY: There has been infestation in Connecticut I believe three years.

DR. C. J. DRAKE: We can't see why there is any exception to the quarantine. We feel all infested territory should be included if it includes any.

MR. L. H. WORTHLEY: The matter of shipping corn on the cob, the product you have reference to, from where the seed corn is grown, has been gone into very thoroughly by Dr. Britton and myself, with the growers there. They don't want to ship any corn out on the cob. We found just one corn borer in those two townships that grow the seed corn which is shipped outside, and that was only found this last season. The infestation heretofore has been up in eastern Connecticut. There was considerable distance between that and the Rhode Island infestation, and the infestation is extremely light. It has been cleaned up each year by Connecticut, and the same condition prevails on Long Island. The infestation there is almost entirely in the weeds, with the exception of one section, and that is being cleaned up and will be cleaned up very thoroughly by the State of New York and the Federal Government.

We are as much interested in this as you folks are and if we found it was necessary to quarantine this area we would be very glad to do so. It is an easy matter to quarantine a place but it is another thing to operate, and if you feel that you are just wasting the money, what is the use of doing it.

DR. C. J. DRAKE: This matter I think deserves careful consideration. I feel we are making a mistake by making an exception to the present quarantine. I don't see why there should be an exception.

I should like to ask another question. Dr. Marlatt stated this morning that Texas and California had passed certain restrictions on the movement of cotton products. Has the cotton quarantine exceeded the present Federal quarantine?

DR. C. L. MARLATT: You refer to the fact that I mentioned that Texas and California had passed restrictions on the movement of products out of areas in a sense that might be perhaps considered as a violation of the principle established by the Supreme Court decision and the amendment.

I think I presented those matters in the light that a new question was raised which hadn't been passed upon by the court and would have to be passed upon by the court probably before it could be settled one way or the other, that is, the question of this injunction which had eliminated Federal action for the moment and left the territory without action of any kind and that the states had taken action with respect to that territory on the theory that the Federal action was absent.

It all comes as an interpretation of whether Federal power having been exerted at all, that eliminates all state action, or whether the Federal power having been exerted, having covered the whole field,

they step in and cover the balance of the field. The legality of that procedure no one but the court can decide.

DR. C. J. DRAKE: There is another question in the present quarantine, regulation 4. There exception is made between the period of June 1 and December 31.

MR. L. H. WORTHLEY: That applies to New England.

DR. C. J. DRAKE: It wouldn't apply to packing in the case of oat straw and the like in the Great Lakes region?

MR. L. H. WORTHLEY: No.

CHAIRMAN S. B. FRACKER: In connection with Dr. Drake's first question, I would suggest that Mr. Worthley outline for us the specific areas in various parts of the United States that are now known to have the European corn borer in them which are not covered in the last amendment. There probably have been some infestations found outside since the board acted.

MR. L. H. WORTHLEY: Other than these which have been mentioned by Dr. Drake, I believe there has been one corn borer found in Illinois, that is in the last week or so. That is right on the Indiana line, I should say about fifty miles south of Chicago.

CHAIRMAN S. B. FRACKER: Then there is one infestation in Illinois and one in Berrien County, Michigan.

MR. L. H. WORTHLEY: Jersey City and Bayonne, Staten Island, Brooklyn, the townships of Hempstead, Bridgeport, and Milford, and three townships near, New London, Groton and Stonington.

CHAIRMAN S. B. FRACKER: In the case of Long Island, is the entire section infested and is the same true of Brooklyn?

MR. L. H. WORTHLEY: Hempstead comes in Nassau County. The Brooklyn infestation is in Queens.

DR. E. N. CORY: I would like to ask Mr. Worthley whether any effort has been made to clean up Bayonne and the tributaries of the Susquehanna River?

MR. L. H. WORTHLEY: Scouting work is being done there now, not scouting work exactly but all river bottom where infestation occurs is now being patrolled by inspectors in an endeavor to get an early clean-up before we get high water. This year, however, we had high water unexpectedly before we got at it. Another season we will try to get at it earlier and see that it is done before there is a possibility, but every river running out of the infested area is being worked on and about one-half of them are completed at the present time.

DR. C. L. MARLATT: I don't want to take any one side in this matter of including the total territory in the quarantine, that is a matter of judgment for the men in charge of the work in the states. In fact, it is a subject which we are not at all adverse to advice upon, but I simply want to call attenton now to the fact that this isn't a new thing. The gipsy moth, for example, has made several outbreaks in states other than in New England.

Several times it has established itself in the state of New York. It has been established for many years in New Jersey. In New York and Ohio, immediate and drastic control work was undertaken. So far as we know, and we have no reason to think otherwise after all these years, these outbreaks were cleaned up.

As I understand it, we have released from quarantine the entire control belt along the Hudson River, from Champlain southward, but it is being released because we have determined to keep it clean, and Mr. Burgess believes he has kept it clean, so that certification of movement of products from that territory has been discontinued, based on the clean-up and the thorough scouting.

These are all on the same basis and illustrate the same principle, as I understand it, which is being followed by Mr. Worthley with the corn borer. Whether that is a good basis or not is a question that is open to debate, but the thing isn't new, it isn't novel, there is plenty of precedent for it. The only question is, and it certainly is very pertinent to know, whether there is any movement this year which leads to a danger of such a nature as to warrant the exclusion of these areas from the quarantine.

DR. A. F. BURGESS: Since the gipsy moth has been mentioned, I just want to say a word in regard to outside counties. Where you have an infested area, the theory of most quarantines has been to permit free movement of materials within that area. If you succeed in cleaning up a portion of the infestation, as for instance a town on the edge of a quarantined district where a single infestation is found, and where continuous work carried on over a period of several years reveals no further infestation, it is safer to eliminate this district from the quarantined area than to permit it to remain inside where there is always danger of reinfestation.

That is the principle that has been followed in connection with the gipsy moth control, and I think that the same principle is true in connection with these points in Connecticut, where Mr. Worthley has been carrying on his clean-up work, and which have been under practically constant observation.

I think it is only fair to say that you can't put on a quarantine and make it absolutely bullet proof. If you do that, you will tie up everything. There are ways that that material will be smuggled out that are almost impossible to foresee.

I think if the quarantine is laid out on the basis of what is fair and what is reasonable, that will accomplish the object. It doesn't make so much difference whether every town where a single insect is found is put under quarantine or not. Mr. Marlatt said Cleveland was never put under quarantine. There was a small colony of gipsy moth found down there. Intensive work was done. We knew where all shipments were going and there wasn't a necessity for quarantine. The place was cleaned up. In New York, that area has been under state quarantine ever since the infestation was found. The conditions in New York state have been much the same as in Cleveland. We had an infestation in Geneva, New York, at one time. Geneva wasn't put under quarantine, but such intensive work was done there that there was no opportunity for spread from that locality.

I think the main thing is to accomplish the purpose and that is to prevent the spread. If you can do it without putting on a quarantine, you are so much better off.

Dr. Wilmon Newell: Mr. Chairman, I would like to have interpreted the proposal of that corn borer committee discussed by Mr. Marlatt. So far as the farmer doing extra work in connection with the corn borer, that is new in our history of applied entomology. It is admitted that is not to be an attempt at reimbursement. All arguments that have been accepted in eradication work would not apply here. When the proposal is shown with all its trimmings, it is simply a proposal to pay the farmers for applying some control measures to an injurious insect.

It seems to me it will be a very happy day for the farmers of this country when Congress establishes a precedent of that kind by appropriating money for that purpose.

Dr. Marlatt explained in detail the ideas of the corn borer committee in reference to the control measures to be employed if the bill which they had framed for the appropriation of $10,000,000 was passed by Congress.

He made it plain that the campaign proposed was not his idea and that his only connection with it was the drawing up of the bill which was merely a clerical matter which he was asked to perform because of his familiarity with the wording of such a document. He also empha-

sized that he was not defending the measure before the meeting but was explaining and discussing it to obtain the suggestions and opinions of quarantine men from the various states.

He explained that the basis for the intervention of state and Federal authority and the expenditure of state and Federal money is the fact that we are dealing with a pest that is not wide spread and generally distributed. We are attempting a degree of eradication, to prevent spread to new territory.

The farmers within the territory where the clean-up campaign is to be carried on will be reimbursed for work which they do in addition to what is usually done in ordinary farm practice. This will amount to about $2.00 per acre, which is thought to be fair and just, as they are not suffering any loss from the insect at the present time, and the additional work is not only for their own protection, but for the protection of the great corn belt beyond them.

He pointed out that the state governments will have to provide the law and authority, and will have to be responsible for the police control and enforcement of the clean-up work, while the Federal Government will help to provide the funds

There is nothing new about carrying on a project of this kind, and the establishing of a precedent by using government funds in this manner need not be considered as it has been done on numerous occasions. The pink boll worm was eradicated from a large area in east central Texas and farmers as well as others were employed to do the work and were reimbursed for what they did.

Mr. Newell said he was not opposed to the experiment being made if it aimed at 100 per cent perfection in eradication. He was opposed however, to the government paying the cost of doing the work.

Mr. Wallace agreed with Dr. Newell, and thought that the expense of doing this work should be borne by the farmers alone. He stated that in Indiana he had organized the clean-up work on this basis and was opposed to the government carrying the expense, as it was not in line with what he had told the farmers in his state. The organization of the work had so far been carried on by three men, but he expected later to have 15 men in the field to carry it to completion.

Chairman S. B. Fracker: I was hoping there would be a rather more general expression of opinion with respect to including some of the infested sections which are not now included in the area. The Wisconsin committee has already passed on its opinion that all of the infested district should be included within the quarantine district.

Dr. Drake speaking for Iowa has expressed the same point of view. Dr. Marlatt has suggested that the board would appreciate the suggestions of others here on that same matter as to the feeling of the different states.

Is there any further discussion of that principle? If not, we will conclude the European corn borer discussion.

The original suggestion regarding this was that a number of other Federal quarantines be taken up, including the gipsy moth and the pink boll worm. What is the pleasure of this body.

MR. P. A. GLENN: I move we adjourn.

The motion was seconded and carried and the meeting adjourned at four-fifty o'clock.

Section of Apiculture

Wednesday Afternoon, December 29, 1926

The first session of the Section of Apiculture of the American Association of Economic Entomologists, held in Logan Hall, University of Pennsylvania, Philadelphia, Pennsylvania, December 29, 1926, convened at two o'clock, Mr. J. I. Hambleton presiding.

CHAIRMAN J. I. HAMBLETON: The first paper on the program seems to be the Chairman's address. I will call on Dr. Phillips to preside.

...Dr. E. F. Phillips assumed the chair...

CHAIRMAN E. F. PHILLIPS: The first item on our program this afternoon will be the address of the Chairman of the Section, Mr. Hambleton.

THE NEED OF A NATIONAL BEEKEEPERS ORGANIZATION

BY JAS. I. HAMBLETON, *Apiculturist, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

A national beekeepers' organization is necessary because today the industry in this country has no head and no center of activity. There is no one guiding power to direct cooperation, and no council to give advice. All worth-while efforts being made at present are individual and as such largely lose their power.

Owing mostly to the nature of the Apicultural Section, most of us present are interested in beekeeping largely from the professional side. Our membership includes apicultural teachers, regulatory officers, and research workers, with a scattering of commercial producers and others who have won some distinction in the great field of beekeeping.

Most of us, therefore, are highly interested in State and Federal appropriations, since our work is to a great extent dependent upon the amounts and restrictions of funds derived from such sources. Since the meeting of this Section offers practically the only occasion for a gathering of a large number of men professionally engaged in beekeeping, I welcome this opportunity to say a few words about certain financial aspects of our work.

In many cases State and university beekeeping officials are to be credited with what has been accomplished in the formation and leadership of beekeepers' organizations. It is also true that they have had to depend largely upon their own efforts to procure appropriations for conducting their respective offices or laboratories. Today such methods seem essential if the work is to continue and any advance is to be made. It is true, however, that such conditions are not ideal, and there is no questioning of the fact that the efficiency of the work in hand is lowered when a teacher, regulatory officer, or investigator, has to spend a considerable part of his time and thought in obtaining funds with which to run his department.

This state of affairs should be remedied, but to remedy it will for some time necessitate further attention to matters other than those pertaining directly to the respective offices in question. There is no doubt that State and Federal work is poorly supported. More research, more teaching, and more extension and regulatory work should be done. I feel that we have just about reached the limit in what can be done along these lines without stronger backing from the beekeepers themselves.

On the other hand, it sometimes appears that State and Federal work is *too* well supported; that the work being done or attempted is appreciated only by a small minority of our beekeepers. Several Government agencies are trying to help the beekeepers, and could do a great deal more for them if government work received better appreciation and support from those most benefited. The same applies in much of the work in many of our States; were it not for individual efforts on the part of State men little or nothing would be accomplished. In several cases it is evident that beekeepers are being trained to ask for what they want, or are being awakened to the fact that they can exert some influence if they go about it in the proper manner. After a certain amount of such guardianship they should be able to steer their own ships in safe and productive channels.

To equip the beekeepers of this country with their own ships, having an admiral in supreme command, is an ideal to look forward to, and an object worthy of attainment. So important is this that I feel that without some such organization beekeeping will never reach anywhere near its maximum development as a respected and profitable business. In spite of whatever prodigious efforts may be made by an individual State, it will never realize its ideal by working alone. Each State must contribute a share to the common pot from which the industry as a whole will receive its nourishment.

An individual State may perfect a marketing organization; it may have an ideal apiary inspection service; other worth-while services may be rendered to the beekeepers. The State may have all the agencies necessary to look after teaching, research, marketing, and inspection, and may in other ways be a kingdom to itself Such a plan is highly commendable, and every State would do well to follow some such course. However, I feel that no State, whatever it may do for itself, will ever attain its objective without the backing of a strong national organization. It may carry on for a time, if sufficient interest and fever heat can be maintained. Those who have had much experience in beekeepers' organizations know how difficult it is to maintain for a very long time the fast pace essential for holding them together.

A national organization is necessary to act as a balance wheel for the work of the various States. It must absorb some of the surplus energy being thrown off now by this State, now by that, and supply to other States the necessary momentum to keep them going on a sane and safe track.

Through these many years the industry has survived. It has made considerable progress. A great impetus was given to beekeeping at the beginning of the World War, and during that period it was beyond question a profitable industry. After the war its status changed considerably; it soon settled back to its pre-war basis, and today is no better off than it was before the war. Advantage was not taken of the boost received when beekeepers were highly interested in their work and in each other.

Today the industry in this country has no head, and no center of activity. There is no guiding hand which can direct cooperation and no council which can give advice. All worth-while efforts being made are individual, and as such largely lose their power. Advantage should have been taken of the interest displayed during the war and immediately after it, and an effort made to hold the industry together and mold it into a unit.

Much effort is being wasted. Beekeepers from one State are wrangling with those of another because of quarantines and differences in inspection laws. Merely because of petty jealousies objections are being made to the expenditure of Federal funds. If such behavior is tolerated, future apicultural activities by the Government will be jeopardized. These activities should be directed into useful channels. Marketing conditions are bad, but no united effort is being made to correct them. Individual States are attempting to remedy conditions, but no two States are working together for the same specific purpose.

We have no reliable statistics on beekeeping; we do not know where our crops are being produced or where our products are going. We are trying to run an industry without accounts or books of any kind. Beekeepers apparently are not worried over this situation; as a matter of fact, in some cases they actually oppose giving information pertaining to their business. In one instance which has come to my knowledge, one of the Department crop reporters, wishing to gather as complete data as possible, singled out a State Association as his source for reporters on beekeeping data, but received absolutely no cooperation. Is it any wonder that with such a display of apathy we make no progress?

We are spending about $100,000.00 annually in the various States in trying to eradicate or control bee diseases, and are proposing that still greater funds be diverted for this purpose. On the other hand, the States are spending probably less than one-half of this amount on all the other apicultural problems put together. These include research on bee diseases, wintering, which alone takes annually a toll of more than ten per cent of all colonies, and every other problem with which the beekeeper's profit is concerned. This does not appear like an equitable expenditure of funds. It is not difficult to imagine what would come to pass if no attempts were made to control bee diseases; disease control I mention specifically, not because I think too much money is being used for this particular project, but that not enough thought and enough money are being diverted towards the solution of our many other problems.

We have drifted into this state of affairs without realizing the true perspective of things. Various States are carrying projects of one sort or another pertaining to beekeeping research and, strangely enough, most of the State projects do not pertain to conditions restricted to the State in which they are being carried on. Most of the problems are of general application and, if we had some agency which could correlate such work and divide the problems among the various investigators, more progress could undoubtedly be made.

Funds have been made available by the Government from time to time for expenditure in the States for agricultural purposes. Only recently the Purnell Act funds were made available; but only two States, so far as I am aware, requested money from this source for beekeeping projects. In a recently published list of 133 projects in home economics, being carried out in our State experiment stations, not a single one related to honey.

Enough instances have been cited to show that the beekeepers of this country have many problems in common and that there are innumerable tasks to be performed which cannot be taken over by any one individual or any one State.

The beekeeping industry is at present handicapped by many unsatisfactory conditions for the betterment of which we do not have sufficient knowledge. More research and study are needed before we can even think of attacking some of our problems. It would nevertheless, be folly to wait until all conditions are propitious before trying to help ourselves. Would it not be better to apply the knowledge we have, for such good as it may do and at the same time systematize and properly relate the elements of the industry so that when new facts are available use can be made of them?

Research cannot progress satisfactorily, whether it deals strictly with scientific or with marketing problems, without being strongly supported by those whom it benefits. In the present state of disorganization beekeepers are not waging a concerted campaign to better their marketing conditions; nor do they seem deeply interested in the solution of many of their other problems, which can be brought about only by extensive research. Perhaps the reason for this is nothing more than neglect. The average beekeeper is so intensely engrossed with his bees that he forgets everything else. In many cases he even forgets to market his crop until he feels the pinch for money, and then generally lets his honey go at the buyer's price.

As I have tried to urge, what is needed is an agency, such as a strong national organization, to guide or to lead. Beekeepers have recently shown what they could do in the fight against the Cole bill, and they can do many more worth-while things by banding together. The impression which I wish to leave in closing is that it behooves every one of us to give attention and thought to beekeepers' organizations, and particularly to a national organization. I sometimes feel that we are working on a very infirm foundation, and that to build a useful superstructure it will be necessary for us to climb down occasionally and do

some work on that foundation. In this connection I hesitate to mention the name of our only existing national organization. It is quite evident that it has not made a big impression on American beekeeping during its existence. For one thing, its constitution is faulty. Something is wrong; and I would suggest that we find out what the trouble is and put our efforts into the construction, or reconstruction, of a truly national beekeepers' organization.

CHAIRMAN E. F. PHILLIPS: I am sure you all feel as I do that we could profitably spend the remainder of the afternoon session discussing the paper which has just been read. There is no need whatever in hiding the fact that the only existing organization, the American Honey Producers League, has been in existence so many years that we can scarcely count them. It has perpetuated by reelecting officers and calling meetings year by year and it has seemingly been the fear of beekeepers everywhere to acknowledge the thing died almost before it was born. So in presenting that subject before us this afternoon Mr. Hambleton has brought up something of very vital interest.

...Mr. J. I. Hambleton resumed the chair...

CHAIRMAN J. I. HAMBLETON: The next paper on the program is by W. J. Nolan.

DO DAILY EGG-LAYING RATES OF LESS THAN 3,000 FOUND BY RECENT INVESTIGATORS INDICATE AVERAGE QUEENBEES?

BY W. J. NOLAN, *Associate Apiculturist, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

A daily gain of 20 to 25 pounds of honey during a honey-flow is considered high for any colony of honeybees. Scientific data as to average nectar loads, number of trips per day, and the amount of water eliminated from nectar after it is brought into the hive indicate that a queenbee having an average daily egg-laying rate of less than 3,000 can produce enough workers to gather an excess of 25 pounds of nectar during any one day. Consequently, recent scientific brood-rearing investigations were made on colonies having average queenbees, even though none of the latter were found to lay over 3,000 eggs in twenty-four hours.

The past thirty-five years have been marked by attempts in various parts of the world to trace out scientifically the normal brood-rearing activity of a colony of honeybees throughout an entire season. Investigators who have been thus engaged, listed chronologically together with the countries in which they worked, are Ph. J. Baldensperger, in

Palestine and southeastern France; Leon Dufour, in northern France; Dr. K. Brünnich, in Switzerland; Dr. L.R. Watson, followed by the writer at the Bee Culture Laboratory of the Bureau of Entomology; Dr. J. H. Merrill, in Kansas; C. B. Gooderham, in Canada; L. R. Hughes in Argentina; and Dr. F. A. Tunin, at the Tula Apicultural Experiment Station in Russia.

The data published by these various investigators have one striking feature in common—in no instance is any evidence offered which would seem to prove that any of the queens investigated attained a daily egg-laying average in excess of 3,000 eggs per day over any 21-day period. Even a daily egg-laying average of 2,000 would fit most of the cases presented. This is quite contrary to what might have been expected, in view of the fact that on more than one occasion statements have appeared in beekeeping literature which would lead to the belief that all exceptionally good honey crops are necessarily prefaced by some high egg-laying rate. "High," in most such instances, has been 3,500 eggs per day or more.

One judging superficially the work of the investigators named might be tempted to say that poor honey-flow conditions explain why lower rates were obtained than those so often given in textbooks. When the localities in which the various investigators worked are listed geographically, however, it is readily seen that nine different localities in seven different countries on four different continents are represented. If soil or honey-flow conditions are the all-important factors in the case, the wide geographical distribution of the places where these investigations have been conducted would seem to have offered a sufficient range of such conditions for them to have caused a corresponding variation in the results.

The relative size of a honey crop obtained by two colonies, each in a different locality, is not a safe index of the relative population or number of field bees in each colony, inasmuch as the number of days during which nectar is available in the field varies greatly in different regions. The maximum daily gain, however, does furnish such an index. Many beekeepers in apparently good beekeeping regions would be satisfied if they could obtain an average of from 5 to 10 pounds of honey a day throughout their main honey-flow. In the Dakotas and western Canada, regions with a large number of days when nectar is available and the regions to which we are now accustomed to look for stories of big honey crops, we find that a daily gain of 20 to 25 pounds is considered high. Such a gain has not yet been authentically reported for any large number

of successive days, however. On studying the daily gains at the various stations at which brood-rearing investigations have been conducted, we find that some of them, at least, compare rather favorably with those reported from the Dakotas and western Canada. At the Bee Culture Laboratory a daily gain of 19 pounds has been obtained, and a daily gain of about 18 pounds has been reported at the Tula Apicultural Experiment Station in Russia. Mr. Gooderham has reported a daily gain slightly in excess of 15 pounds at the apiary in Canada in which his experiments were conducted. Doctor Merrill reported that one of the colonies on which he worked in Kansas in 1924 stored 159 ⅞ pounds of honey between June 10 and August 31, the highest daily gain having been 10 pounds. Mr. Baldensperger's locality yielded sufficient nectar for him to make a living from his bees. It is quite evident that such results would not have been obtained from colonies whose development had been retarded by want of stores during the time of building up; an undersized colony could not collect so much honey on any one day. In this connection it may be well to bear in mind that the average annual production per colony for the entire United States since 1913, as reported by the Bureau of Agricultural Economics of the United States Department of Agriculture, is below 50 pounds per colony.

It is possible to examine these brood-rearing results in the light of scientific data now on hand relating to various other factors which affect the honey flow, and thus to determine whether an average daily egg-laying rate of less than 3,000 will produce enough field bees to gather a satisfactory quantity of honey daily. These other factors include the average amount of nectar brought in per field bee per trip, to be designated in this article as *a;* the average number of trips per field bee per day of average length, to be designated as *b;* the number of field bees, to be designated as *c;* and the proportional part of the original weight remaining after the nectar carried in has undergone any process of water elimination, to be designated as *d*. Now the daily gain in *honey* for any colony is evidently equal to these four factors multiplied together. In short, using the symbols given above,

$$abcd = \text{daily gain in } \textit{honey}$$

It remains for us to make substitutions in the foregoing formula to determine what average egg-laying rate will give a satisfactory daily gain. Quite evidently the unknown quantity in this case is involved in *c*, which represents the number of field bees. It has been widely held that the average life of worker bees in a normal colony during the height

of the active season is only six weeks, and that the first three weeks of this time are devoted to hive duties and the last three to field duties. It should be emphasized that these figures are averages, and individual exceptions may occur in either direction. Some writers have maintained that the length of life during the most active season is only five weeks, but this is offset by the fact that others hold that the worker begins its field duties at the end of the second week. Some even maintain that the average life of the worker during the active season is longer than six weeks. In any event, it seems that a period of field duties averaging three weeks satisfies the results obtained by most investigators, whether the length of life is taken as five or six weeks. This means that the minimum field force on any one day during the most active part of the season may be considered as equaling the number of emergences during the three-week period immediately preceding the average period spent in hive duties. The rate of emergence for any particular period is, in turn, equivalent to the *effective egg-laying rate*[1] during the corresponding period three weeks earlier. In healthy colonies under normal conditions the effective egg-laying rate is practically equivalent to the egg-laying rate determined from counts of sealed brood, with the possible exception of the extreme ends of the season. The effective egg-laying rate will be designated here by x. Bearing in mind the time which elapses after an egg is laid until the resulting adult bee takes up field duties, the number of bees in the field force may be found by the equation

$$c = 21\,x$$

Since the daily gain in honey is expressed in weight, it is necessary to express the number of field bees in like terms. In this country it has been quite commonly accepted that there are 5,000 bees to the pound, although variations have been reported in either direction. Hence, in substituting for c in the formula for the daily gain, not $21\,x$, but $\frac{21\,x}{500}$ is to be used.

In substituting for a, the average nectar load carried by worker bees, a wide range is afforded by data at present on record. Doctor Merrill, of Kansas, in 1922, Professor Lazenby, of Ohio State University, in 1899,

[1]The "effective egg-laying rate" was defined by the writer in an article "Colony Population and Honey Crops," appearing in *Gleanings in Bee Culture*, volume 53, pp. 366–368; pp. 443–446, as follows: "The egg-laying rate which represents only those eggs resulting finally in additions to a colony's population may be termed the effective egg-laying rate, in distinction from the actual egg-laying rate, which includes all the eggs laid. This rate for any day or period, of course, is identical with the rate of emergence for the corresponding day or period three weeks later."

and Professor Koons, of Connecticut, in 1895, presented data which show that the average loads carried by bees investigated by them were equivalent to one-quarter of the average weight of a worker bee. Doctor Park, of Iowa, in 1922, however, as well as Professor Gillette, of the Colorado Experiment Station, in 1897, and Mr. Demuth, in unpublished work done while with the Bee Culture Laboratory of the Bureau of Entomology, have shown that the average load is equal to one-half of the average weight of worker bees. Doctor Park found, furthermore, that the maximum carrying capacity is 85 per cent of the worker's weight, and Professor Gillette found bees in emerging swarms carrying practically their own weight in honey. Mr. Demuth also found bees carrying their own weight in honey when robbing. Doctor Merrill, however, did not find the maximum carrying capacity much greater than the average carrying capacity; but Professor Koons found it to be equal to about one-half of a bee's own weight, and Professor Lazenby found it to be slightly in excess of one-half of a bee's own weight. For the purpose of this paper, the minimum average figure found by any of these investigators, one-quarter, will be substituted for a in the formula for daily gain.

The question of the average number of daily trips which a bee makes during a good honey flow is likewise a subject on which we may find varying opinions. Doctor Park has reported that in 1920 he found bees making an average number of 13 ⅓ trips per day, whereas in 1921 a season with a poorer honey-flow, the average number dropped to 7 trips per day. In 1920 the maximum number of trips per day found by him was 24; in 1921 it was 17. Certain investigations carried on by the writer, as well as results given in the works of others, lead to the conviction that Doctor Park's average figures are not excessive. In fact, they are far below what have been reported by certain other investigators. Thus, Hommell in his book reports that Astor had observed a certain marked bee which made 110 trips per day to a feeder on two successive days, while Demeure observed a marked bee which made 60 trips in one day. For the purpose of this paper it seems quite conservative to use 10 trips per day as the value to be substituted for b. In case the average number of trips is really greater, the effective egg-laying rate could be reduced proportionately.

We now come to the last substitution to be made on the left-hand side of the equation, namely, the fractional part left after the nectar which has been gathered by the bees undergoes any elimination of its water content. Although nectar has been found to vary much in its water

content, and although apparently it has often been supposed that all loss of this water takes place by evaporation in the hive, yet certain investigators, including among them Brunnich, maintain that a portion of the water is already lost between the time when the bee gathers the nectar and when it deposits the nectar in the cell. At any rate, all scientific investigations along this line point to the fact that during a good honey flow any loss in weight which occurs as a result of the elimination of water content in nectar after it is deposited in the hive is only about 25 per cent, or less. This result has been shown most recently by Jas. I. Hambleton. Dufour, Maujean, and other earlier workers likewise obtained the same result. It is well known that nectar in certain of our western regions loses far less than 25 per cent in weight after it comes into the hive, but for the purposes of this article we shall consider that only ¾ of the weight carried into the hive by the bees during the nectar flow is left as honey. This is the value then to be substituted for *d*.

In order to have a daily gain which will be far higher than is usually found in most localities throughout the entire world, we shall consider that the average gain in twenty-four hours is 20 pounds of honey. This is equivalent to about 27 pounds of fresh nectar, assuming that as high as ¼ of its original weight will be lost by the elimination of water after it is in the hive. Substituting 20 pounds on the right-hand side of the formula for daily gain, as well as the values given previously for *a*, *b*, *c*, and *d*, the equation becomes

$$\frac{1}{4} \times 10 \times \frac{21\,x}{5000} \times \frac{3}{4} = 20$$

Solving for x, the average daily effective egg-laying rate necessary to meet the values given for nectar loads, number of daily trips, number of field bees, and amount of daily gain, it is found to be 2,540. This theoretical effective egg-laying rate is at once seen to be quite in line with that obtained empirically by the various investigators named earlier in this paper. If we assume the maximum number of trips per day found by Park, this egg-laying rate would be cut in two, or else the amount of honey obtained would be doubled. If we assume the lower rate of evaporation found in certain of our western regions the egg-laying rate would likewise be lowered, or else the amount of honey brought in per day would be greatly increased. The same holds true if we use only the average nectar loads found by Park, Demuth and Gillette, to say nothing of using the maximum loads found by these investigators. In this connection it must be remembered that bumper crops are only

obtained under optimum conditions, whereas in solving this problem the maximum figures obtained by various investigators have not been used. The use of these maximum values, however, would surely indicate that the egg-laying rate obtained by this formula is too high or else we have never yet obtained the maximum crop of which present day colonies are capable. Needless to say optimum conditions in all respects are not to be expected often in commercial beekeeping.

The results of present day investigations on brood-rearing, therefore, judged by scientific data on other factors determining the honey-flow as given here, indicate that a colony whose queen lays even less than 3,000 eggs per day on an average over a sufficiently protracted period at the proper time is capable of producing an exceptionally large honey crop. If we attempt to reconcile these results with the statements so long current in text books which would lead one to suspect that the average daily egg-laying rate of an ordinary queen is much higher, leaving out any question as to the accuracy of the observations, one is led to conclude that either (a) the basis for all such statements as to the high egg-laying averages were only sporadic occurrences, or else (b) that in these later years queenbreeders have lost sight of prolificness as a quality of any great importance in their queens if they have made any attempts at selective breeding. It would appear, then, that one of the direct benefits which beekeepers in the future may derive from the artificial fertilization of queenbees is the obtaining of more prolific strains of bees than are generally met with at the present time, in short, the production of queenbees whose egg-laying rates will average in excess of 3,000 per day at the proper time of the year.

CHAIRMAN J. I. HAMBLETON: Is there any discussion on this paper? I believe Mr. Nolan has made one point clear, that a great many bee-keepers and queen breeders do not like to admit that their queens can't make an average daily laying of over 3,000 eggs per day, but Mr. Nolan has certainly shown that a queen that is only laying 2,500 eggs per day can bring in 20 pounds per day without working herself unduly.

CHAIRMAN J. I. HAMBLETON: We have Mr. Sechrist's paper on "Honey Grading."

HONEY GRADING

By E. L. Sechrist, *Associate Apiculturist, Bureau of Entomology, United States Department of Apiculture*

Commercial beekeeping in the United States has undergone a great development during recent years. Many a beekeeper now devotes all his energies to honey production, managing hundreds or thousands of hives of bees and producing tons or carloads of honey yearly. The production of such large quantities of honey in regions where only a small proportion of it can be consumed locally demands the development of larger markets in the great consuming centers—the large cities.

To handle such wholesale markets satisfactorily, including a developing foreign market which now takes more than five million pounds of honey annually, honey, as in the case of all food products, must be marketed according to uniform standards. Realizing this, the Bee Culture Laboratory of the Bureau of Entomology, in cooperation with the Bureau of Agricultural Economics, has established standard Federal grades and grading rules for both comb and extracted honey. Earlier attempts at making grading rules have usually approached the subject almost wholly from the standpoint of the honey producer, leaving out of consideration the demands of the consumer of honey, but, as the consumer is the court of last resort, it is necessary that his desires and the requirements of the dealer in honey be considered, as well as the wishes of the beekeepers themselves.

The effect of proper grading upon the American public and thus upon the market for honey is the most important thing to be expected from uniform Federal grading rules. The use of Federal grades will give a general confidence now lacking in the purity and quality of honey; a confidence which must be secured before honey can become a staple food product. If confidence in the good quality of honey marketed under Federal grades leads to even a moderate consumption of this product by a majority of the households in the United States, as may reasonably be expected, a greatly increased market for it will be secured and the status of beekeeping in the United States will improve accordingly.

The accurate color grading of honey has been made possible, after several years of experimental work, by the development of a color grader whose operating principle is the comparison of a wedge of glass of the proper color with an opposed wedge-shaped trough containing the sample of honey to be tested. When the honey and the glass, viewed through a narrow slot, exactly match in tint, a pointer on an

appropriately divided scale indicates the color grade into which each sample falls. Department Circular No. 364, on the development and use of the extracted honey grader, has been published, but will soon be superseded by a new circular covering the grading of both comb and extracted honey.

Clearness, density, and flavor are other points, in addition to color, on which the grades for extracted honey are based.

Although the grading of extracted honey is comparatively simple, the numerous points on which comb honey must be graded make the problem a complex one. Not only must the quality and the color of the honey be considered, as with extracted honey, but also the appearance of the comb and of the wooden section in which the square of comb is built. This general appearance, or finish, includes the color of the wax, the smoothness and completeness of the capping, and any staining of the surface of the comb by propolis or in any other way. As comb honey is very fragile, the attachment of the comb to the wood must be such that the honey will endure without breakage, the rough treatment to which it is subjected in shipping. As an increasing amount of comb honey is going into export trade, the requirements for overseas shipping must also be considered.

In addition to the requirements for quality of honey, finish of comb, and attachment to the wood, comb honey is also graded as to its net weight.

As though the conditions were not yet sufficiently complex, the requirements for Federal grades must be such that all commercial honeys from all parts of the United States, from whatever floral source, and often varying markedly in appearance, may come within the requirements of the rules.

While the Federal grading rules are only advisory, it is expected that they will be adopted by the several States, working in harmony, since there are many requests for uniform standards of grading.

In the future, instead of merely producing a crop of honey and then grading it into Fancy and No. 1 to suit the crop he has produced, it will be necessary for the commercial beekeeper to plan his system of management so that he can produce the largest proportion of honey that will meet the requirements of the Federal grades for Fancy and No. 1 honeys, if he is to receive the greatest possible income from his beekeeping. If a sufficient output of such standard grades is produced the public will be able to buy, as a staple, such honey as the housekeepers desire to use on their tables.

CHAIRMAN J. I. HAMBLETON: We also have Mr. Park's paper on "Studies on the Evaporation of Nectar."

STUDIES ON THE EVAPORATION OF NECTAR[1]

By O. W. PARK, *Iowa Experiment Station, Ames, Iowa.*

ABSTRACT

Results of recent experiments by the author indicate that no concentration of nectar occurs within the body of the bee between the flower and the hive entrance, but that evaporation in its several phases, carried on within the hive is sufficient to account fully for the observed rate of nectar concentration.

The two theories that have been offered in explanation of how the honeybee reduces the high water content of nectar to the low water content of honey, are known as the *excretion* and the *evaporation* theories. The first of these is based largely upon the well known observation that bees carrying thin nectar or thin syrup often eject a tiny spray of colorless liquid. As early as 1878, Rauschenfels (1) and others assumed that this was the result of a process within the body of the bee whereby some of the excess water was eliminated from the nectar while the bee was enroute to the hive.

De Planta (2), at about the same time, arrived at a similar conclusion from the results he obtained from the analysis of nectar, new honey and old honey, in which he found that honey newly deposited in the cells reached them already considerably concentrated.

Thompson (3) and A. I. Root (4) collected and tasted some of this spray. Both reported it to be tasteless and as far as they could tell was only water.

THE EXCRETION THEORY

Brünnich (5, 6, 7) has developed an interesting theory in which he states that the membranous wall of the honey-sac allows water to pass thru it into the blood of the bee, from whence it is removed by the rectal glands and discharged by them into the rectum.

If the excretion theory is valid, an analysis of the nectar taken from the honey-sac of a bee entering the hive with its load should show a greater concentration of sugar than would nectar taken directly from the plants from which the bee obtained its load. A number of analyses of this character were made during the past summer on nectar from two

[1]The writer desires to express his sincere appreciation of the hearty cooperation given by the Department of Chemistry of Iowa State College. Special thanks are due Dr. R. M. Hixon, Plant Chemist, for his valuable assistance and guidance in the analysis of nectar.

different sources. Analyses were run in duplicate in practically all cases in order to guard against errors.

The first plant used was the common milkweed (*Asclepias syriaca*). Analyses were made of eight samples of nectar taken directly from the flowers and seven from the honey-sac contents of milkweed nectar-carriers caught as they were entering the hive. These analyses showed decisively that the nectar taken from the honey-sac of the returning field-bee was not more concentrated than that taken directly from the flowers. As a matter of fact, the average found for the concentration of sugar in the nectar taken from the bees was eight per cent lower than that for the nectar taken directly from the flowers. This decrease in concentration appeared as a rather constant factor and in only one case did the honey-sac contents show a higher concentration than the average for nectar from the flowers themselves. One such exception is not more than should be expected in an experiment of this nature in which the bees caught at the hive may have secured their loads from a group of milkweed plants other than that from which the nectar was gathered by the experimenter.

The second source of nectar used in these experiments was the gladiolus (*Gladiolus* sp.). This plant yielded nectar in quantities that could be collected and fed to the bees, thus eliminating the factor suggested in the preceding paragraph as a possible source of error. Field-going bees were used. Each bee was marked, placed in a queen-nursery cage, and kept there without food for an hour. A single large drop of nectar was then placed on the screen of each cage. Only those bees which took up a large drop were used further, thus insuring that every bee used had a full load of the nectar provided for it, and that it had none from other sources. These bees were then released at a distance of one-half mile from the hive and were captured when they returned to the hive. The nectar was then recovered after having remained within their honey-sacs for approximately one hour. Analyses were run on the nectar recovered from the bees, as well as upon a sample of the nectar as it was obtained from the flowers.

The following day, the experiment was repeated, only in this case a harmless coloring material was added to the nectar before it was fed to the bees, so that not only were the bees marked but the nectar itself was marked also. Hence it would have been impossible for one of those bees to get rid of the load it was given and acquire another from a different source before returning to the hive, without being detected. The nectar was analyzed both before and after the coloring was added,

and again after it was recovered from the bees. The results of this experiment were almost identical with those obtained the previous day when uncolored nectar was used. In both of these cases the concentration of sugar was about one per cent less in the nectar taken from the bees than it was before being fed to them.

Several questions arise. Why was the decrease in concentration so much greater in the case of milkweed nectar than in the case of gladiolus nectar? As suggested above, the bees caught at the hive might have been working on a group of plants other than that from which the experimenter collected his sample. It is possible also that some few of the bees used may have carried loads from plants other than milkweed, although every one of the bees used bore the pollinia of the, milkweed, clipped onto her feet and legs. The writer's earlier researches on the habits of field-bees (8) indicated that a bee seldom changed from one kind of flower to another in her gathering until her particular kind was no longer available. It is unlikely, then, that this factor would enter in until towards the end of the blooming period, but the analyses showed marked uniformity throughout the whole period.

Another possible cause of this difference in results from the two different sources is the fact that in the case of the gladiolus, the nectar was quickly obtained by the operator in considerable quantities whereas, in the case of the milkweed, the process of collecting a sample from the flowers was very much slower, and smaller quantities were obtained, so that there was greater aeration of the milkweed nectar. A loss of water by evaporation would tend to increase the concentration of the nectar. This factor probably is responsible for some part of the apparent difference but that it could account for all of it seems to the writer improbable.

But the explanation which to the author seems most plausible is that the milkweed nectar was twice as rich in sugar as was that from gladiolus. So in order to bring about proper conditions for rapid inversion of the sugar, it was necessary for the bees to add a greater quantity of the enzyme to the more concentrated solution, thereby reducing its concentration to a greater extent than was necessary in the case of the more dilute nectar from gladiolus. It is well known in regard to the inversion process, that the more concentrated the solution, the slower the action.

Are we, then, to conclude that a dilution instead of a concentration process goes on in the honey-sac between the flower and the hive entrance? The data at hand are not considered sufficient to warrant such

a conclusion. They are ample, however, to show that no concentration occurs between the flower and the hive. Moreover, they certainly suggest that some dilution may occur.

What, then, is the source of the droplets of clear liquid ejected by bees when carrying thin nectar or syrup? As yet no direct experiment has been carried out to determine this point, but methods have been worked out by means of which it is hoped the answer may be secured during the coming season.

Concentration By Evaporation

If we consider the excretion theory disproven, the only remaining explanation that has been offered as to how bees concentrate nectar is that of evaporation. Does this method adequately account for the actual rate of concentration? Brunnich (7) believes it does not, and cites the work of Huillon as well as some experiments of his own. It is impossible to describe or discuss these experiments in a paper as brief as this one must be, so let it suffice to say that the methods used by both of these investigators were so indirect and the experiments so wholly lacking in controls that the results obtained are scarcely comparable to those secured by the direct methods and careful controls employed in the present investigation.

It remains to be shown whether evaporation can and does proceed at a rate sufficient to account for the observed facts. Evaporation of nectar is known to have two phases: evaporation from the tongue of the house-bee, and from the cells of the comb. The first mentioned phase has been discussed by the writer in previous articles (9, 10), so it will be necessary only to remind the reader that during the manipulation of the nectar by the mouthparts of the house-bee, a most excellent opportunity for rapid evaporation is provided. It is not known whether the nectar is handled in this manner more than once, but if it is this would account for a very rapid rate of evaporation. While the extent to which nectar is concentrated by this means is not yet definitely known, there are reasons to believe that it may be the most important single factor in the concentration process.

Evaporation from the cells of the comb also presents two phases: evaporation from hanging drops of thin nectar, and evaporation from the new honey after being placed in the cell in the usual manner. Here again the writer has already shown, in the articles referred to in the preceding paragraph, that when nectar is being brought in more rapidly than it can be taken care of in the usual way, the house-bee does not stop to manipulate each load as received but "hangs it up to dry."

A tiny droplet is hung in the roof of each of several empty or partly empty cells, which frequently are occupied by eggs or young brood. These small hanging drops present relatively large surfaces from which moisture can escape rapidly. Later the droplets are collected and it is assumed they are then put through the usual process of manipulation by the mouthparts. This phase of evaporation must be of considerable importance at times of heavy yields, especially when the nectar is very thin.

So far we have been dealing with phases of evaporation, the importance of which seems apparent, but a measure of their importance is not readily established. It was found feasible, however, to obtain valuable data on the rate of evaporation from nectar located in its usual position in the cells. The experiment follows.

Glass cells, having the same diameter and depth as worker cells, were prepared. A frame was made having sockets to receive and hold them in the position of the cells in a comb. The cells were thoroughly cleaned, dried in the oven, and carefully weighed on chemical balances. Nectar freshly collected from gladiolus was placed in the cells and the amounts accurately determined by weighing. The cells were then fitted into their sockets and the whole frame was enclosed in a wire screen cage which allowed the entire apparatus to be hung in a normal colony next to a frame of brood. No bee could reach these cells, but the warmth of the hive and the currents of air were free to play their parts.

It was expected that the amount of nectar in the cell would influence the rate of evaporation, so three sets of cells were used, one set had only one drop at the back of each cell, the second set was filled about one-fourth full, and the third nearly three-fourths full. At the end of 24 hours, some of the cells of each set were removed, their loss in weight, and their sugar content determined. Whenever analyses showed less sugar than had been found in the nectar when first gathered, it was considered that fermentation had set in and the results were treated accordingly. But so long as no sugar was lost, the losses in weight were considered to be due to evaporation alone. At the end of the second day, another lot of cells was removed and treated in a like manner, and so on for a period of seven days.

For the sake of simplicity, let us discuss the results of this experiment in terms of concentration, keeping in mind the fact that ripe honey has a concentration of about 80 per cent. For convenience let A, B and C represent the three groups of cells, group A having the least and C the most nectar. The results for groups A and B were so nearly identical

that the figures for group B only will be mentioned. The nectar when first collected, contained 13.5 per cent sugar. Briefly stated, the concentration for group B actually rose to 79.5 per cent or that of ripe honey during the first 24 hours. During the next six days there was comparatively little change.

The results for group C must be qualified because fermentation set in before the end of the first day. The amount of sugar lost in this way was so slight, however, that considerable light was thrown on the rate of concentration in cells nearly filled with thin nectar. If we assume, in this case, that all loss in weight was due to evaporation, then the nectar in the cells of group C advanced in concentration to 30 per cent the first day. That is, it only a little more than doubled its original concentration whereas, the nectar in groups A and B increased its concentration six-fold in the same length of time. Had there been no fermentation the actual rate of concentration for group C would have been a little lower than that indicated above. Hence the expectation was borne out that, within certain limits, the larger the amount in a cell, the more slowly evaporation takes place. (A large amount of available comb space must greatly facilitate the concentration of nectar.) After the first day, fermentation progressed so rapidly in group C that further results were not usable.

Other experiments along this line were performed but space does not permit a description of them here. Without exception they all showed a very marked loss by evaporation during the first day, often a moderate loss the second day, and sometimes a small loss the third and fourth days. The rate of loss was found to depend principally upon three factors: the relative humidity of the atmosphere, the amount of nectar in the cell, and the initial concentration of the nectar. The higher the initial concentration, the more slowly did it lose water.

The results of further experiments are needed before drawing ironclad conclusions, and further work along these lines is contemplated. The present paper is offered only as a preliminary report, but it is believed the experiments related above are sufficient to show, beyond any reasonable doubt, that evaporation from nectar in the cells can account for a very large part of the concentration process. It is the author's belief, however, that the evaporation which takes place from the mouthparts of the house-bee may be of equal importance; and that evaporation in its several phases can fully account for the observed rate of nectar concentration.

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CHAIRMAN J. I. HAMBLETON: I will call for the next paper.

GASEOUS CHLORINE AS A DISINFECTANT FOR AMERICAN FOULBROOD INFECTED COMBS[1]

By RAY HUTSON, *Assistant Entomologist, N. J., Agricultural Experiment Station*

ABSTRACT

Gaseous chlorine, commonly used as a water purifier, killed *Bacillus larvae* the causative organism of American foulbrood in 48 hours. This was demonstrated by culture and field experiments. The treatment of infected combs with this gas cuts labor costs but has the disadvantages, as used, of injury to frames, and where honey is present, to bees.

The beekeeper who has not wished for a cheap comfortable method for making American foulbrood infected combs usable again must be unimaginative. Fumigation such as that employed after scarlet fever and other contagious disease has suggested itself to many. France (1) tried out a scheme apparently patterned on this idea in 1903. Formaldehyde gas did not disinfect any better then than it has in later years as shown by White (2,3), by Maasen and Borchert and by Borchert(4). Gaseous chlorine, extensively used as a water purifier, would doubtless have been tried against foulbrood long ago were it not for its much advertised danger in handling which appears rather overrated when it is recalled

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that 65% of North America's population drink chlorinated water (5), a fact necessitating the daily handling of chlorine in quantity by men of many grades and variations of intelligence. No trouble whatever was experienced in the experiments detailed. The precautions observed were those of keeping the valve on the chlorine container closed when not in use and keeping to leeward when it was.

PRELIMINARY TESTS. Before any combs were treated with chlorine microscopic examination of the material was made and the gross diagnosis confirmed (6).

The laboratory tests of gaseous chlorine as a disinfectant for American foulbrood were made by subjecting pieces of infected comb 2 x 3 inches to the gas in museum jars with water present. The moisture being introduced because chlorine is more active in its presence. The combs remained in the gas filled jars 48 hours. The pieces of comb were then allowed to dry and slant cultures made on Jones (7)modification of Sturtevant's yeast extract agar, observing the usual precautions of asepis. No growth was evident after 48 hours incubation at 37°C., of five cultures from open and five cultures from sealed cells, in each of the four pieces of comb used. The tests were twice repeated with like results.

APPARATUS. These trials resulting in apparent disinfection the next step was to treat whole combs. The devising of a cheap container that would retain the gas long enough to accomplish disinfection of several combs at once, presented considerable difficulty. It was finally surmounted by nailing on a bottom and hinging a cover with paraffine impregnated felt gaskets to a "Modified" Dadant hive. Inlet for the gas was provided by a copper tube sealed in near the bottom at one end by means of a rubber stopper. Means for the escape of air as it was displaced by chlorine was provided by a glass tube sealed in near the top of the container at the opposite end. Both tubes had short lengths of rubber tubing fitted with screw pinchcocks. A thorough coat of hot paraffine to the inside of the box and it was ready for use.

THE TREATMENT. About a quart of water was poured in the bottom of the container. Four dry infected brood combs and four infected brood combs containing a few cells of honey were hung in by resting the end of the topbars on the metal rabbits left in the one time hive body. The cover was then closed, fastened by a hasp, and sealed with hot paraffine. The next step was to connect the gas cylinder to the inlet. Chlorine was then let in until its characteristic yellowish green color was very apparent in the glass outlet tube. The valve controlling the flow

of gas was then closed and the pinchcocks clamped on the rubber tubing, thus subjecting the infected combs to the action of the gas at atmospheric pressure. Batches of combs were treated in this way for varying periods, removed and placed in a screened enclosure for the marked chlorine odor to dissipate. This was not complete after 62 days exposure.

FIELD TESTS. A comb which had contained no honey when fumigated for 48 hours was placed in a colony April 16th, 1925, and examined daily. The first eggs were seen in it April 23rd. From that time on it was examined weekly. No foulbrood having appeared by June 2nd, 1925, more combs were placed in colonies in another yard. Two hives received dry combs and two hives had combs containing cells of honey. All had been fumigated 48 hours. These colonies were examined July 3rd and clean brood found in the treated combs. On August 16th, 1925, however, all had developed American foulbrood as had the other three colonies in the yard. The first comb tried still had clean brood. That fact and the circumstances surrounding the infection of the second yard called for another trial. This was had during the season of 1926. Dry combs and combs containing honey were fumigated 2, 3, 4 and 8 days and given to queen right colonies. Weekly examinations until brood rearing ceased late in October failed to show the presence of American foulbrood.

ADVANTAGES. Calculation shows the cost of this method has the advantage of cutting labor cost about 90%. If repeated trials still show no infection from stray cells of honey this will cut labor costs still more. No molds or insects are apparently present after treatment. Overlooking a cell or two of honey does not mean reinfection.

DISADVANTAGES. Chlorine attacks any exposed metal. Honey in a comb is extremely messy after treatment with chlorine. It apparently kills approximately 1% of larvae and bees when as much as two pounds are present. Bees do not take to the treated combs as readily as they should.

SUMMARY. Gaseous chlorine used in the presence of moisture at atmospheric pressure killed the spores of American foulbrood in dry brood combs and in brood combs containing occasional cells of honey in 48 hours. A paraffine coated box holds the gas at the pressure used for sufficient time to kill the germs. The gas attacks any metal about frames and renders any honey present very messy and is apparently poisonous to bees.

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MR. JAMES C. GOODWIN: Did the chlorine affect the wire in the foundation, when using wire combs or wire foundation? How long did you retain the comb before you put them back in the hive where you got your kill of one per cent of your brood?

MR. RAY HUTSON: It did not attack wire in the comb; it attacked wire where it was exposed. "Any exposed metal," the wording of the paper was, "was attacked." Wires imbeded such as in the vertical wired foundations were not attacked. You see there is no pressure there. It is atmospheric pressure and beeswax is comparatively an inert chemical substance. The bleaching, of course, of the organic matter other than the wax was quite noticeable.

In regard to your other question of how long they were kept out, they were kept out as long as the period that I mentioned there, sixty-two days, and still we had that trouble. That is the only thing I could tie it to, because we did not have it in the dry comb. There is one of those hives that has been going two years with those combs in it.

DR. E. F. PHILLIPS: I was going to say that it occurred to me when Mr. Hutson was describing his experiment there might be some trouble in the utilization of a method such as this by changes in atmospheric pressure externally. We get a shifting of atmospheric pressure approximating one inch between high and low pressure areas. That could be very readily overcome by introducing a little rubber balloon between the gas intake and the hive and leaving that constantly in contact so that the pressure of the gas inside would always equal that of the gas outside.

MR. RAY HUTSON: That is the same scheme that the Standard Oil and other gas companies are using on their gasoline storage tanks.

DR. E. F. PHILLIPS: The reason it occurred to me is because that is always used, for instance, in the experiments. It always must equalize the pressure inside and outside and on a box as large as a hive, with a difference of one inch in the atmospheric pressure you get quite a cracking or bulging of the thin cover, or something of that kind.

CHAIRMAN J. I. HAMBLETON: I would like to ask Mr. Hutson whether the damage to the metal was serious during the time when the combs were being treated.

MR. RAY HUTSON: In all cases where the wires were exposed, you know the corners of the combs where the wire would be exposed, it was eaten through—that was No. 28 wire. Forty-eight hours was the minimum treatment. In all treatments I had that trouble.

CHAIRMAN J. I. HAMBLETON: I would like to appoint a Nominating Committee. On this committee I would like to appoint Professor Robinson, Mr. Sams, Dr. E. F. Phillips.

I wish this committee would report before we adjourn.

DR. E. F. PHILLIPS: I wonder if I might say a few things while Dr. Bertholf is getting ready. We all listened to the remarks of the Chairman this afternoon with a great deal of interest when he discussed the situation with regard to a national organization of beekeepers. For the benefit of those who were not present at Medina, Ohio, at the Root-Langstroth Memorial meetings which were held there in September, it might be well to say that at that time Mr. Hambleton brought this same question forward and proposed that a national organization of beekeepers be formed. We met rather informally at Medina to discuss this subject and at that time it was the consensus of opinion that it would be desirable for Mr. Hambleton to constitute himself a committee of one with such assistance as he might be able to get from others to outline a program for such an organization and to write a constitution or by-laws and whatever else might be necessary for the formation of such an organization.

In the meantime Mr. Hambleton has done this work. I don't know whether he had any help or not, but at any rate the work is completed and he has here a constitution and a set of by-laws for such an organization. If it is in order, Mr. Chairman, I move that immediately at the conclusion of the discussions this afternoon we take up the matter of the discussion of a national organization of beekeepers.

CHAIRMAN J. I. HAMBLETON: You have all heard Dr. Phillips' motion. Is there a second?

...The motion was seconded and carried...

CHAIRMAN J. I. HAMBLETON: We will take up that discussion immediately after the selection of officers.

I will now call on Professor Bertholf.

THE RELATIVE SENSITIVITY OF HONEYBEES TO LIGHT OF DIFFERENT WAVE-LENGTHS

By L. M. Bertholf, *Western Maryland College, formerly of Bee Culture Laboratory, U. S. Dept. Agriculture*

Abstract

Honeybees two or three at a time, were placed under a large petri dish into which entered two narrow opposed beams of light, the intensity of one of which could be varied by means of a rotating disc photometer. The bees in trying to get out of the dish ran to the two spots where the beams entered. By counting the number of times they bumped into the glass at each of these two points one could ascertain which light had the stronger stimulating effect. Colors, except yellow, were obtained by the use of Corning glass filters, the yellow filter being a potassium dichromate solution. The transmission curve of each filter was accurately known, the peaks of the curves being well separated. Violet, blue, green, yellow, and red were used. When each of these colors was opposed by a white light it was found that the latter had to be reduced by a certain amount in order to equalize the opposing color in stimulating effect. Using, then, the total radiation per unit area of each filter, as determined at the Bureau of Standards, the relative stimulating efficiency of the colors turned out to be as follows: green 100, blue 54, yellow 29, violet 23, red 2. When these numbers are plotted on the same scale as the curve of the relative sensitivity of the human eye, as worked out by Coblentz, it is found that the curve lies farther toward the violet end of the spectrum than does the curve for the human eye and does not extend as far into the red. It shows decidedly that red does not stimulate bees as much as it does humans, and that violet stimulates them more than it does humans.

Mr. George H. Rea: My work is among the practical beekeepers. A few years ago while Dr. Phillips was in Washington he told me of some experiments he had carried on along this line. He gave me the idea that it might be practical to use a red light in a bee cellar in putting bees into a cellar and taking them out again. I found it was very highly practical. If we use a white light when setting bees into a cellar, a great many of the bees will fly out and go to the light, but when we use a red light, we find very rarely if ever a bee goes toward the light. It doesn't seem to attract them out of the hive. It has an intensive practical value.

Chairman J. I. Hambleton: I see that Mr. Frison has come into the room, and I will call on him for his paper.

THE FERTILIZATION AND HIBERNATION OF QUEEN BUMBLE-BEES UNDER CONTROLLED CONDITIONS. (*BREMIDAE:* **HYM.**)[1]

By Theodore H. Frison, *Illinois State Natural History Survey Urbana, Illinois*

Abstract

The fertilization and hibernation of queen bumblebees under controlled conditions is essential if these useful insects are ever to be domesticated, or semi-domesticated, by man. Experiments of this nature were conducted during 1916, 1917, 1919 and 1920. The results prove that the fertilization and hibernation of certain species of queen bumblebees can be obtained under controlled conditions.

In the fall of 1916, 1917, and 1919, I conducted a series of experiments to determine whether or not the copulation and resultant fertilization of *Bremus* queens could be secured under controlled conditions. The only experiments of a similar nature, of which I am aware, are those of Sladen (1912). In one of the experiments conducted by this investigator, copulation was observed to take place between the queens and males of *Bremus lapidarius* (Linn.). There have been, also, but few attempts to induce bumblebees to hibernate under controlled conditions. Mr. Warren Williamson, in 1910, at Urbana, Illinois, tried to winter a large number of queens of *Bremus americanorum* (Fabr.), but they all died. One of these queens, however, still exhibited weak signs of life on the first of April. In England, Sladen (1912) tried to winter bumblebees, but never succeeded in keeping a queen alive later than the eighteenth of September.

A. Mating Experiments

All of the queens used in my mating experiments were reared from colonies housed in observation boxes. The males were either reared in the same manner as the queens or collected from flowers and brought alive into the laboratory. Quart glass fruit jars, the tops of which were tightly covered over with several layers of cheese cloth and the bottoms of which were lined with corrugated paper to afford the bees a good footing, served admirably as cages during the course of these experiments. Old bumblebee cocoons, fastened in the middle of the corrugated paper bottoms, were used as containers for the liquid food supplied the bees. When I was ready to begin a mating experiment I usually placed

[1]Contribution from the Entomological Laboratories of the University of Illinois, No. 110. Extract number four from a thesis presented to the Faculty of the Graduate School of the University of Illinois in May, 1923, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

a queen and one or more males of the same species in the same jar. Prior to this time; the males and queens were kept apart. I have found that males isolated from the time of their emergence from queens are more easily incited to attempt copulation, when suddenly placed with a queen, than are males kept continually in association with them. I have also observed the same reaction in the case of fossorial wasps of the genus *Tiphia*. In some instances the introduced male was indifferent to the queen and I found it desirable to substitute another male. This shifting about of males often had the desired effect. It sometimes happened that the queens killed by stinging the males first placed with them but then later accepted another male. In a few extreme cases, the queens immediately killed or repeatedly viciously attacked all males placed with them.

During the early part of July, 1917, I tried to secure the fertilization of reared queens of *Bremus bimaculatus* (Cress.) by tying a fine thread about the body of a queen and then fastening the free end of this thread to some tree, bush, or flower growing in the open. I tried this with so few queens, however, that I can not judge of its true worth. It merits recording, nevertheless, that by this means males could be attracted to queens, but copulation was never observed. A detailed discussion of the normal manner in which the queens are fertilized and the various actions associated with this activity are given in another paper dealing with the general behavior of these social insects.

Table 1 gives in tabulated form the results of sixty-six mating experiments tried in 1916, 1917, and 1919. This table clearly shows that my efforts were rewarded with gratifying results. Furthermore, I have no doubt that with the information I now possess concerning the factors requisite to success, the failures could be substantially reduced. This is evident when one considers that I obtained better success each succeeding season that the experiments were conducted. It is interesting, also, to recall in this connection that the controlled fertilization of the honeybee has not been satisfactorily achieved.[2]

In studying the figures in Table 1 it must be borne in mind that an experiment was judged a success only when the bees were actually seen *in coitu*. As I did not have an opportunity to observe them continuously, some of the experiments listed as resulting questionably or unsuccessfully may have had a successful termination. This is support-

[2]A recent article in the American Bee Journal (November, 1926) reports the successful accomplishment by Mr. L. R. Watson of Cornell University of the artificial mating of the queen honeybee.

ed by the fact that in many experiments listed as failures, the males were observed at one time or another attempting to copulate with a queen. In 1916, single queens were used in all experiments, but in 1917 and 1919 as many as thirty queens and twenty-five males were used in a single experiment. Thus, though only sixty-six experiments were performed, a total of one hundred and thirty-eight males and one hundred and forty-four queens were under observation.

TABLE 1

Year	Species	Number of Experiments	Successful	Questionable	Failures
1916	*B. americanorum* ♀ ♂	33	11	15	7
1916	*P. variabilis* ♀ ♂	4			4
1916	*P. variabilis* ♀ *B. americanorum* ♂	1			1 (mating attempted)
1917	*B. bimaculatus* ♀ ♂	2	1	1	
1917	*B. auricomus* ♀ ♂	3			3
1917	*B. americanorum* ♀ ♂	17	14	3	
1917	*B. americanorum* ♂ *B. auricomus* ♀	1			1 (mating attempted)
1917	*B. americanorum* ♂ *B. auricomus* ♀	1		1	
1919	*B. bimaculatus* ♀ ♂	1		1	
1919	*B. vagans* ♀ ♂	3	3	x	
1919	*B. americanorum* ♀ ♂	1	1		

B. Hibernating Experiments

Several years previous to 1916 and 1917, I tried to induce bumblebee queens to hibernate. These queens were secured in fall from every possible source. Frequently more than fifty queens were used in these early experiments, but the queens always died before December of the same year. Repeated failures led me to believe that temperature conditions and the lack of fertilization were responsible for the death of these queens. Therefore, in 1916, 1917, and 1919, I allowed the queens access to males for several days before trying to use them in hibernating experiments. Because of other duties I was unable to watch these queens and males constantly, and therefore could not determine in most cases whether or not the males and queens mated. In some cases, however, the bees were observed *in coitu* and were accordingly considered as fertilized. The remainder of the queens had access to males and may or may not have been fertilized. Notwithstanding the fact

that all the queens were not actually seen *in coitu*, this certainly placed the experiments on a sounder basis and gave more promise of success.

After the queens were allowed access to males, I placed them in separate jars for a few days and provided them with an abundance of pollen and diluted honey. This procedure was then followed, in the fall of 1916, by placing the queens out of doors during a cool night in order to get them into a stupor for transfer to cold storage. The following morning I removed all queens treated in this manner to cans containing loose soil and dried leaves, and then put them in one of the cold storage rooms of a local ice plant. Thirty-six experiments of this character were made in 1916–1917, involving twenty-eight queens of *Bremus americanorum* (Fabr.), one of *Bremus separatus* (Cress.), and seven of *Psithyrus variabilis* (Cress.).

In the fall of 1917, because of my many failures in 1916, I tried out new methods of hibernating queens which had previously had access to males. This time I placed several well fed queens in separate small glass jelly jars with perforated lids. These jars contained a small amount of loose soil and old leaves. Several other queens were placed in perforated paper mailing tubes, which in turn were enclosed in quart fruit jars with perforated lids. The remaining queens were placed in mailing tubes inside perforated tin cans containing a small quantity of loose soil and old leaves. All of the tubes, jelly jars and fruit jars were then buried about a foot from the surface in a small mound of earth or directly in the ground. Eleven separate experiments were made in 1917–1918, in which were used eleven queens of *Bremus americanorum* (Fabr.), seven of *Bremus bimaculatus* (Cress.), and three of *Bremus auricomus* (Robt.).

In 1916–1917, I did not succeed in hibernating a single queen. A queen of *Bremus separatus* (Cress.) found on October 14, 1916, hibernating in a natural state in a log in the Brownfield Woods, Urbana, Illinois, by Mr. H. G. M. Crawford was still alive on March 29, 1917, but never recovered sufficiently to make the experiment a success. In 1917–1918, four queens of *Bremus americanorum* (Fabr.) were hibernated with perfect success. These queens were the ones placed in paper mailing tubes within fruit jars and cans on October 1, 1917, and then buried in a mound of earth. Because of an interruption of my studies these queens were allowed their freedom in April, 1918. A queen of another species, *Bremus bimaculatus* (Cress.), which was placed in similar hibernating quarters on September 3, 1917, was alive and apparently healthy when removed on March 2, 1918. In 1919–1920, I partially succeeded in

hibernating a queen of *Bremus auricomus*. In this latter experiment, however, the queen died on February 10, 1920, several days after she had been forced to become prematurely active. Because of the success obtained in 1917–1918, only a couple of experiments of this nature were undertaken in 1919–1920 and none in subsequent years

I am sure one factor influencing the heavy mortality in these experiments, particularly my first experiments, was that the queens were kept too long under conditions demanding a fairly high rate of metabolism. Under natural conditions the new queens do not fly about much after leaving the nest, and shortly after leaving it seek hibernating quarters. Many of the queens used in these experiments were kept active under warm laboratory conditions almost a month longer than they were to be seen flying in the field. The fact that many of them were found dead in their hibernating quarters but a short time after being placed there is ample evidence of the deleterious effects of such treatment. There is apparently no reason, however, why large numbers of well-fed. fertilized queens placed in hibernating quarters at the proper time of year can not be succesfully hibernated by the methods used by me in the fall of 1917.

CHAIRMAN J. I. HAMBLETON: Is there any discussion on this paper? If not, we will call on the Nominating Committee for their report.

DR. E. F. PHILLIPS: The Nominating Committee finds it is somewhat handicapped because of the fact that according to the regulations of the Association, only active members can hold office. There are quite a number of associate members, and I would suggest before the next meeting some of them take steps to make themselves eligible for office. (Laughter).

We desire to nominate Professor F. E. Millen of the Ontario Agricultural College as Chairman, and following a long custom of the Association, we desire to nominate Professor Bentley as Secretary.

I move that nominations be closed and no objections be entertained.

CHAIRMAN J. I. HAMBLETON: Any discussion?

...The motion was carried...

CHAIRMAN J. I. HAMBLETON: That finishes this part of the meeting. We will have a session in the Medical Hall this evening.

DR. E. F. PHILLIPS: I move that we adjourn and proceed to discuss the other question.

...The motion was seconded and carried and the meeting adjourned at three-thirty o'clock...

Wednesday Evening, December 29, 1926

The meeting convened in the Medical Hall of the University of Pennsylvania at eight-five o'clock, Mr. J. I. Hambleton presiding.

CHAIRMAN J. I. HAMBLETON: The first paper on the program is by Dr. Phillips on "Some Things I saw and heard while visiting Beekeepers and their Societies in Europe in the Summer of 1926." Dr. Phillips needs no introduction.

...Dr. E. F. Phillips addressed the meeting for one hour on his European trip...

BEE JOURNALS AND ORGANIZATIONS IN EUROPE[1]

By E. F. PHILLIPS *Ithaca, N. Y.*

ABSTRACT

The status of beekeeping publications in Europe is discussed and the desirability of official organs by the various organizations of beekeepers in the United States is suggested.

In German Switzerland, having an area about equal to that of four New York counties, there is a strong association of beekeepers which publishes an official organ which goes to all of the 17,000 members. French Switzerland is equally well organized and the society maintains an excellent official organ. In France practically every Department has a strong society of beekeepers with an official organ. Each departmental society in France does not publish its own bee-journal but several of the bee-journals are reprinted under different names for the different societies. In this manner the beekeepers of the entire country are well provided with current information on all beekeeping subjects.

In Great Britain the situation regarding bee-journals is somewhat different from that on the continent. The British Bee Journal is not published by the British Beekeepers' Association but is privately owned. It is, however, the official organ of the Association and goes to all members. Some of the county associations in England are not affiliated with the general society and in some cases these county societies issue their own organ. For example the Kent, Surrey and Gloucestershire

[1]At the evening session of the Apiculture Section, December 29, the author addressed the Section on a visit to Europe during the summer of 1926, during which time he had opportunity to visit twenty-five associations of beekeepers. Since space will not permit the publication of the full talk, it seems desirable to limit the present paper as indicated by the above title. These remarks constituted the close of the talk before the Apiculture Section.

societies publish a fine journal, Bee Craft, as their official organ. The Bee World, the organ of the Apis Club, is widely read, but it occupies a somewhat different place in beekeeping, since the Apis Club is an international organization, the organ of which goes to all members in all countries.

Scotland is thoroughly organized and the federated societies publish an excellent journal. Wales and Ireland also support official organs through their federated societies.

In other countries on the continent of Europe, the organizations of beekeepers are even stronger than in the countries visited last summer. Exact data are not available, but there is reported to be a federation of beekeepers in Germany numbering 180,000 members. Austria is also well organized and the same is true for other European countries. In all these cases, the societies are strengthened and maintained through the publication of official organs.

When one of the European societies is formed, it appears that almost the first step is the establishment of an official organ through which the members may be kept in touch with their society. By this means also the beekeepers are provided with information of a current nature on beekeeping topics. Since the publication of a journal entails a heavy financial burden, the success of the society necessitates the getting of as many members and consequent subscribers as possible, so that it becomes necessary that those interested in beekeeping be sought by every possible means. Instead of the listless attitude so often encountered in our societies, there is a constant hunt for interested beekeepers to assist in supporting the societies and their journals.

By way of marked contrast, let us look at the journal situation in the United States. It is doubtful whether more than 30,000 out of the 800,000 to 1,000,000 persons who own bees in the United States subscribe for a bee-journal. A few of our societies have undertaken the publication of official organs, but in all these cases they have avoided direct competition with the existing bee-journals. Two of the bee-journals published in the United States have a distribution of national scope and both are excellent journals, worthy of being read by beekeepers everywhere. Other bee-journals have a more limited appeal and consequently a more limited distribution.

Since under the present arrangements for the distribution of current beekeeping literature in the United States only a small fraction of the beekeepers are receiving a bee-journal, one is led to the belief that we might take a lesson from the experience of our European co-workers and

that progress in beekeeping in the United States might be greatly assisted by the establishment of official organs, at least by the more powerful state societies. We can not afford to follow the example of the European societies blindly, but if after a careful study of our conditions it appears desirable to establish such journals, then this program should be pushed actively throughout the country. I am strongly of the opinion that this is the most vital immediate step in the development of American beekeeping.

Since the two bee-journals which now enjoy a national distribution are of such high class, some may feel that nothing should be done which will in any way work to their detriment, and in this view I heartily concur. There is, however, reason to believe that competition from official organs would assist rather than hinder these journals, if in no other way, by bringing these journals to the attention of beekeepers.

Beekeeping in the United States is at present in a state of depression, owing chiefly to a disorganized honey market. The present does not at first glance seem a propitious time to launch new journals, yet on the other hand beekeeping was never in greater need of every possible assistance. If the establishment of some strong official organs would help materially in the revival of interest on the part of beekeepers, or if they would assist the beekeepers by helping them to understand the marketing situation, then there was never a time when such organs were more badly needed.

CHAIRMAN J. I. HAMBLETON: Are there any questions?

This afternoon after the Section on Apiculture adjourned we discussed a little while the formation of a national organization. After hearing Dr. Phillips recite his experiences, as he says he is only giving you a small part, I wonder what we beekeepers would do if some famous European beekeepers came over to this country. I don't think we could reciprocate under present conditions of disorganization.

The next feature of our evening session will be a demonstration of the instrumental insemination of the queenbee.

DEMONSTRATION OF INSTRUMENTAL INSEMINATION OF THE QUEENBEE

By LLOYD R. WATSON, *Cornell University, Ithaca, N. Y.*

ABSTRACT

The breeding of honeybees along definite lines of genetical and race improvement has to the present been impossible because the mating of the queenbee could not be controlled. She pursues her once-for-life nuptials in the open air free on the wing and she persistently refuses to mate under any other conditions.

After 150 years of research by numerous experimenters in many lands, it has now for the first time been conclusively demonstrated by Dr. Lloyd R. Watson of Cornell University that she can at least be outwitted. By means of a sort of surgical operation involving very delicate microtechnique which is carried out under the lenses of a binocular microscope, the sperm from a selected drone is dissected out, and with the aid of a microsyringe, which in turn is stabilized and controlled by a micromanipulator, it is injected into the oviduct of the virgin queen as she rests dorsal side downward in a cradle carved out of a tiny operating-table, and held motionless by several loops of silk thread thrown over her body and around the table.

To the present time about 50% of all the treated queens later showed insemination ranging all the way from perfectly normal down to very slight. This procedure is not adapted to the use of the ordinary beekeeper, nor to that of the ordinary commercial queen-raiser, but it is adapted to the use of any microscopist who knows bee-behavior and who can bring to the problem a fine degree of manual control.

The bees which you see before me on the table have come all the way from Texas to be here tonight. The shipping north of queens and drones in the dead of winter is in itself an experiment. They have arrived in fairly good condition as regards the queens, but the drones have not stood the journey so well and many of them are dead. The queens are of course in individual cages but the drones came scattered thru about three pounds of workerbees, and we thot it necessary to etherize the whole stock it order to sort out the drones from the workers.

We are never too old to learn, and I have just learned that drones take ether much more easily than workers or queens do. As a result many of our drones did not recover consciousness, altho we gave the lightest amount of ether which would still make the workers desist from flying. However, we are fortunate in that, as many previous experiments have shown, the sperm in mature drones may remain alive and active for a long time after the drone is apparently dead if the temperature is not too low. I believe that we shall have no trouble in getting active sperm for this occasion.

I want to say a word about "artificial." This word has bothered me for a long time. I have not liked the word "artificial" in connection with this operation. In the first place no new or artificial substance is substituted in place of a natural substance. It seems to me that placing

semen in the oviduct of a queenbee by instrumental means is no more artificial, or not indeed so artificial as Caesar was, and we hardly speak of him as artificial.

I have been searching in my mind for some word to use instead of the word "artificial." As far as possible I am going to omit from this discussion the word artificial and I am going to employ the word "instrumental" in its place.

The problem of controlling the mating of honeybees is a time-worn problem, and it has been attacked from many different angles. I think I have attacked it from about all the different avenues of approach that anybody ever has. Of course those ways were not original with me, for a long list of respected and conscientious experimenters have struggled with this problem for 150 years. In common with others I have tried confining virgin queens with drones in limited spaces. I have tied queens out on a lariat to fly among drones. I have tried holding the queen and the drone in juxtaposition in an effort to effect a sort of forced copulation, but never with success. Finally in 1923, after several years of trials and failures of various sorts, it occurred to me that instrumental insemination by a sort of surgical operation seemed the most likely to give success, and I began seriously upon this line of attack then.

I once saw a recipe for making rabbit soup, and it gave this advice which is probably sound and which I have never forgotten: The first consideration in making rabbit soup is to secure the rabbit. Well, the first consideration in the instrumental insemination of the queenbee is to secure the queen so that she shall be held perfectly still and unable to wiggle her thorax or her abdomen. She must be placed in this condition without being hurt and she must at all times be kept comfortable. Here is a virgin queen from southern Texas. The fingers of the operater must be soft enough to handle the queen without hurting her, and if the handling of a queen simulates a scuffle, then we may be almost certain from the first that the experiment will not be a success.

This queen is placed dorsal side downward in this little cradle which I have hollowed out of this piece of wood, and which exactly fits her head, thorax and abdomen. I carefully wind her down with this silk thread. Most of the pressure must come on the thorax; it must not come on her abdomen, and I must be very sure that none of the strands fall over her throat. As I wind I withdraw my thumb, always noting that her legs and wings are left in a natural and comfortable position. The bee is such a non-communicative organism that there is no language in which

we can speak to it, and it can give back no communication to us. We possess so little in common with bees that it is hard for us to sympathize with them, but we must have a certain sympathy for them if we are to succeed with this business. Now the queen is secure on this little operating-table. She is perfectly helpless but she is comfortable. I will turn her over to you to be passed from hand to hand for your examination while I prepare the syringe.

I have never had such a fine opportunity to study the virility of drones. I believe that drones are not functionally mature before they are ten or twelve days old, and they are much better when they are older than that. For this demonstration I asked for drones that would be older than ten days, and I suspect that these are older for I noticed that when they took the ether many of them ejaculated. This is a sign of maturity.

Having selected a drone which appears normal, I snip off his head. Curiously enough the shock of decapitation sets up stimuli in a drone which very closely simulate natural copulation, and if a drone is anywhere near the right age, he will usually ejaculate forcibly. I have usually found that if they do not ejaculate forcibly they are immature.

In nature in the act of copulation, the drone, you will recall, is not able to withdraw the penis from the vulva of the queen, and it is torn from him. Likewise, we seize this fellow in the same way and tear from him his genital organ. During ejaculation the sperm from the seminal vesicles is crowded down the ejaculatory duct first and then immediately behind that follows the pearly white mucus from the accessory mucous glands. The sperm and the mucus occupy distinct regions in the seminal pouch with possibly loose mixing, and with the unaided eye I can now see these distinct regions as the turgid seminal pouch lies upon the index finger of my left hand. The sperm is creamy yellow but the mucus is pure white. When I pass my finger into the field of this binocular microscope which is equipped with 36-millimeter objectives and 6x oculars, thus giving a magnification of 15 diameters, I can see the sperms lashing thru the transparent wall of the penis.

For this work I am using a microsyringe which I made in my private laboratory. The inside diameter of the plunger-barrel is five-tenths of a millimeter and the stroke of the plunger is 13 millimeters. This gives a working capacity of about .25 cubic millimeters. The syringe is designed to hold all of the sperm produced by a normal drone plus a little of the accessory mucus. The inside diameter of the syringe nozzle closely approximates the diameter of a queen's egg. Not until I reduced

the syringe to about this size was I able to inseminate queens without injuring them.

This syringe is mounted, as you see, in a brass block called a Barber pipette-holder, and tilted up to an angle of about 40 degrees to enable me to look into the vestibule of the queen while I work. These three milled heads permit me to move the pipette forward or backward, right or left, or up and down in the three planes in space. The plunger of the syringe is controlled by this fine brass screw and head. The plunger itself is a straight piece of 30 gauge stiff brass wire and wound about the end with cotton and shellac.

We now proceed to fill the syringe. The penis of the drone still resting on my finger is first passed into the magnified field and up to the point of the syringe. The plunger is advanced till it stands just flush with the opening of the nozzle. The finger is now cautiously moved up till the nozzle of the syringe acting as a hypodermic needle, pierces the penis wall and enters the region of the mucus. By manipulating, the screw-head the plunger is backed and about one-half of a cubic millimeter of the mucus is taken up. By advancing the finger again the nozzle is now made to enter the region of the creamy sperm and this is all taken up. As the now collapsed penis is withdrawn from the nozzle a tiny drop of the mucus is allowed to cover the open end of the syringe to protect the sperm from the air and from desiccation while the queen is being arranged on the stage of the microscope.

Is there anyone who would like to look thru the microscope to see the loaded syringe. The lashing of the sperms is quite visible. (Those present passed by the microscope to see Dr. Watson's work.)

Now the queen has been resting on the operating table comfortably for twenty minutes or more. She has been fed. So now we proceed to inseminate her. She is placed on the stage of the microscope with the tip of her abdomen in the middle of the field and pointing toward my right. Now comes the critical test of one's nerve. The making or the ruining of a perfectly good queen lies in this operation. Sometimes I sit for a moment or two and try to hold the points of two needles together to train and calm my control. With this pair of finest-pointed tweezers in the left hand and a moderately sharp applicator in the other hand I cautiously approach the queen and force the genito-anal plates apart and place the points of the tweezers between them in such a way that when the tweezers are allowed to open a little, the oviduct, sting, rectum and vestibule floor are exposed to view. With the microscope lamp and reflector properly placed the vestibule is now flooded with

light. As I manipulate the screws of the pipette-holder with the right hand the syringe is advanced and made to stand just over the opening of the oviduct but not yet into actual contact with it. At this point the plunger is advanced enough to break the little mucous cap which has sealed the sperm away from the air and as this is done the syringe is lowered till its tip just disappears within the vulva of the queen. While the tweezers in the left hand still retract the genito-anal plates, the right hand manipulates the plunger and the charge of semen begins to flow out of the syringe and down along the oviduct. With a light as strong as this, the floor of the vestibule is rendered quite transparent and I can easily see the course of the sperm as it descends and dilates the oviduct.

I was greatly puzzled for a long time to know whether in natural copulation the male merely deposited the sperm in the oviduct or whether he actually reached in and placed it in the spermatheca. I went so far as to make a syringe with the nozzle turning upward intended to lodge the sperm within the spermathecal duct but no operations with this instrument were successful. Furthermore, the examination of numerous young queens just returning to the hive from the wedding flight revealed the fact that in natural copulation the drone merely deposits the semen in the oviduct and the sperms then migrate by their own activity into the spermatheca.

Now the semen has all entered the oviduct and I back the syringe away. As I do this I force out the mucus which entered the syringe first as it was being filled, and leave this in the vulva of the queen just as the drone does to seal it from the air for a few hours till the sperms have had time to find their way into the spermatheca where they are safe and where they will live for years as long as the queen lives or till they are used one by one for the purpose of fertilizing her eggs.

I would be willing for you to come and view this queen thru the microscope before I let her up but perhaps we would better not keep her here much longer. Mr. Nolan, will you not please step to the microscope and perhaps you can tell them how it looks. I am going to hold the vestibule open while you glance.

MR. NOLAN: I see the plug.

DR. WATSON: Thank you. All there is to see is a mass of white mucus extending out of the vulva and around the base of the sting. This queen is ready to be released and if she wasn't too sick from the ether she could fly right off. She doesn't limp; her wings are not crumpled. She is all right. (Applause.)

Are there any questions you would like to ask?

QUESTION: How long does the mucous plug remain in the vestibule?

DR. WATSON: In normal copulation that plug will be gone in from one to five hours.

QUESTION: How is it removed?

DR. WATSON: Most of it seems to be absorbed by the queen but part of it appears later as a little hard scale. Sometimes she claws or pushes it away with her legs and sometimes the workerbees pull it away.

QUESTION: How long does the sperm remain alive after you remove the seminal vesicles from the drone?

DR. WATSON: I have observed it to remain active for two hours in my laboratory at about 80 degree temperature.

MR. HAMBLETON: Have you ever performed this operation on a drone layer?

DR. WATSON: I never have.

QUESTION: When these queens are introduced into a colony are they accepted as normal queens are?

DR. WATSON: I see no difference providing that she has been properly handled. When a queen has been wounded or pretty badly malled over, I have known the bees to refuse to accept her, but if she is all right they take her in and begin feeding her at once.

QUESTION: And her own reactions in the colony, are they the same?

DR. WATSON: They are normal. Ten minutes after she is put back into the colony you would hardly dream that she is an instrument queen.

Here is an item which I wish to mention in closing. You have never seen this in the literature but I think you will very soon. It is a common phenomenon, you know, that a newly mated queen rapidly grows larger. An experienced observer can usually tell in a very few hours whether a queen has mated because she becomes so sedate, slow and so heavy to fly. I used to wonder whence she derived that added nourishment. At the time of copulation, all of the white mucus is given to her and it is disposed of by very rapid absorption. I think that it is this which gives her the tremendous metabolic impetus to develop as she does.

CHAIRMAN J. I. HAMBLETON: I am sure that this has been quite a wonderful opportunity to see this operation performed, in view of the fact that investigators have been trying for years and years, and no one yet has been able to demonstrate the fact. While we have no proof

here that this particular queen will lay fertile eggs, Dr. Watson has been able to satisfy his graduate committee that he has done this thing repeatedly and he has queens in his own yard now that he has instrumentally inseminated that are laying in every respect normally.

So far as I know this is the first public demonstration that has been made. I am sure that we shall all look forward with great interest to what this work will result in.

OBSERVATIONS ON *BUCCULATRIX GOSSYPIELLA*, A NEW AND IMPORTANT COTTON PEST

By A. W. MORRILL, *Los Angeles, California*

ABSTRACT

A species of cotton infesting Bucculatrix (Family Lyonetiidae) described as *B. gossypiella* Morrill,[1] infests wild and cultivated cottons in the states of Sonora and Sinaloa, Mexico. The adults closely resemble another cotton infesting species, *B. thurberiella* Busck, but can be separated by the genitalia in both sexes, while the egg and larval stages of the two species are strikingly different. The larvae of *B. gossypiella* have the peculiar habit of boring in woody or hard tissues of the plant, such as stalks, branches, carpels of green bolls, leaf petioles and larger leaf veins as well as in the leaf blades and bracts with decided preference for the harder parts. Characteristic reddish spots are produced by the work of the larva in the plant tissues. Damage appears to be confined to the staining of the lint and to producing deformed and imperfectly opened bolls, usually amounting to between 10 and 30 per cent of the crop. Observations to date indicate that early planting favors maximum damage and late planting favors minimum damage but local concerted action as to delayed planting and clearing of old cotton fields may be necessary where large acreages are involved.

In the course of a survey of insects associated with Arizona wild cotton, or *Thurberia thespesiodes*, in Southern Arizona in 1913[2] a species of Bucculatrix was discovered which was described by Mr. Busck[3] as *Bucculatrix thurberiella*. This species has become very common and sometimes injurious in cultivated cotton fields of Southern Arizona and Southern California, and also in the northern part of Lower California and the northern part of Sonora, Mexico. It becomes less abundant in southern Sonora and northern Sinaloa, and apparently does not exist in southern Sinaloa and in Nayarit.

The Thurberia Bucculatrix, or cotton leaf perforator exhibits feeding,

[1]Proc. Ent. Soc. Wash., Vol. 29, pp. 94–97, 1927.
[2]Pierce and Morrill, Proc. Ent. Soc. Wash. Vol. XVI, pp. 21, 1914.
[3]Busck, Proc. Ent. Soc. Wash. Vol. XVI. pp. 30–31, 1914.

moulting and other habits typical of the genus.[4] The attack on cotton is confined almost entirely to leaf blades, with the occasional exception of the calyx and involucral bracts. In September 1923, injury by micro-lepidopterous larvae to the carpels of green cotton bolls was observed by Dr. W. M. Mann and the writer in the Yaqui Valley near Cajeme, Sonora, Mexico. The cocoons and adults appeared to be identical with *B. thurberiella* and it was not until the writer had an opportunity for a comparative study of all stages in the field in 1924 and 1925 that specific differences were discovered.

Distinctions Between the Two Cotton Infesting Species of Bucculatrix

The egg of *B. thurberiella* as described by McGregor is elongated, projectile shaped with about 10 projecting ridges and stands perpendicular to the leaf. The unhatched egg is pale straw color. The egg of *B. gossypiella* is flattened, scale like, has as a rule five longitudinal ridges converging toward the micropilar end. It is clear transparent or greenish color before hatching and the egg shell after hatching is light brown in color.

The full grown larvae of the two species are as easily distinguished as the eggs. That of *B. thurberiella* invariably has conspicuous black spots and whitish tubercles on every segment of the body as described by McGregor, while the larva of *B. gossypiella* has distinctively arranged black spots on the pronotal shield and anal plate and more or less obscure flattened tubercles conclorous with the yellowish body except in unusually dark colored individuals. The larvae of the former species, on account of the two rows of large black spots, are in general appearance darker than the cotton leaf while the larvae of the latter species are always more or less lighter. The average length of five normal individuals of *B. thurberiella* was 5.64 mm. with a range of 5–6 mm. while the average of five individuals of *B. gossypiella* was 4.76 mm. with a range of 4.3–5.5 mm.

Five specimens of the pupating cocoons of *B. thurberiella* were found to be uniformly approximately 5.5. mm. in length while five specimens of the cocoons of *B. gossypiella* ranged from 4 to 5.5 mm. in length, averaging 4.9 mm.

The pupae and adults of the two species differ in size, *B. thurberiella* averaging considerably larger than *B. gossypiella*. The male and female

[4]A. W. Morrill, Sixth Ann. Rept. Ariz. Com. Agr. and Hort. pp. 44–46, 1914. E. A. McGregor, Jour. Econ. Ent. Vol. 9, pp. 505–510, 1916.

genitalia of the two species are conspicuously different in structure. A comparative examination of the pupae of the two species has not been made.

In the cotton field the feeding habits of the larvae, as hereinafter described, give an infallible distinction between the species which any cotton grower can easily recognize.

Food Plants

In addition to American upland and Egyptian cottons, *B. gossypiella* attacks several species of Mexican wild cotton including *Gossypium davidsonii* Kellogg, *G. hypodenum* C. and H., *G. patens* C. and H., *G. contextum* C. and H., *G. morrilli* C. and H. and *G. dicladum* C. and H. The cultivated cottons appear to be preferred as food plants over the wild cottons.

Of the wild cotton species named, *G. davidsoni* being a practically lintless and therefore useless plant and growing in great abundance in uninhabited coast districts, appears to be the most attractive as a food plant and the most likely to be the native food plant of the cotton Bucculatrix. The other wild cotton species produce an abundance of lint which is sometimes used by the natives. These plants are almost invariably found growing in door-yards where they have been planted for shade or ornamental purposes, or growing in locations where it is apparent that they are to be regarded in a sense as escaped from cultivation.[5] These lint producing wild cottons are very likely to have been introduced in prehistoric times from the south but it seems unlikely that the cotton Bucculatrix was introduced from this direction for these insects would rarely if ever be carried with seed and, furthermore, if the species were introduced it would be almost certain to have been first established in southern Sinaloa and Nayarit where it appears to be absent on both wild and cultivated cottons.

Distribution

The cotton Bucculatrix occurs throughout central and northern Sinaloa, Mexico, and as far north as Guaymas, Sonora. It was not found in the Altar valley of northwestern Sonora in September, 1925, in the course of a cotton pest survey of that district. It has not been found in the extreme southern Sinaloa, in the state of Nayarit or in the vicinity

[5]*G. morrilli*, recently described by Cook and Hubbard (Proc. Wash. Acad. Sciences Vol. 16 p.339, 1926) may be an exception as the seed from which the type plants were grown was obtained from plants growing in uninhabited districts on the Sonora coast.

of Torreon, state of Durango. The locations where the species has so far been discovered are as follows: Guaymas, Cocorit and Cajeme, state of Sonora, Los Mochis, Cachuana, Guasave and Navolato, state of Sinaloa. All of these localities are less than 100 feet above sea level.

Observations on Life History and Habits

Adult Activity. The adult of *B. gossypiella* shows no activity during daylight unless disturbed when it flies only a few feet at the most. Slight activity is shown at dusk while the greatest activity is at night. On November 17, 1926, near Cajeme, Sonora, the writer made special observations on adult activity. No adults were seen during daylight in one-half hour's search for active moths. Immediately after sundown two adults were noted crawling on cotton leaves during a ten minute search, while after the twilight period a ten minute search with a flashlight in the same location resulted in finding eight specimens actively crawling on leaves and other parts of the cotton plants. None of the moths have been observed at lights in houses located near infested cotton fields, in one case within 100 feet, and no attraction to lights was shown in connection with the above mentioned use of flashlight in a cotton field.

Place of Egg Deposition. Eggs of *B. gossypiella* are deposited on nearly all exposed parts of the cotton plant. The tops of the leaves in the angles formed by veins at junctions with leaf petioles and the carpels of green bolls are about equal in rank as preferred locations. New woody branches up to ½ inch in diameter follow closely in order. When the insect is present in abundance, scattering eggs may be found generally on leaf blades, on petioles of leaves and on pedicels of squares and bolls, on involucral bracts and on the buds. When abundant, numerous eggs can be found on practically every leaf except perhaps those located low down on the plants. The examination of a random collection of 60 more than half grown green bolls in one instance gave an average of 9.9 eggs per boll ranging from 0 to 32. In one other instance 55 eggs were counted on one green boll. A 12 inch section of a shoot of an Egyptian cotton plant ¾ inch in diameter at the base and tapering to ¼ inch, representing a typical condition, was found to have a total of 36 eggs scattered from one end to the other. In contrast with these observations it should be noted that the eggs of *Bucculatrix thurberiella* are scattered at random on the leaf blades with only an occasional one found on the involucral bracts and calyx.

Feeding Habits of Larvae. The larvae enter the plant tissue directly from the egg and the empty shell remains covering the en-

trance hole. If it finds itself in a leaf blade the larva circles around the point of entrance for a short time then makes its way along a branch vein to a large vein or to the junction of the leaf blade and leaf petiole. Occasionally a blotch like or trumpet shaped mine is produced in the leaf tissue but never, so far as observed, a clear cut serpentine leaf mine similar to that made by *B. thurberiella*. Although observations to date are not conclusive, it appears that the majority of the worms which begin their larval development in parts of the plant other than in bolls and buds come to the surface at the end of the second larval stage. This is supported by the fact that the exit holes from such parts, as shown by measurements of 10 representative ones, average about .36 mm., ranging from .3–.6 mm., whereas in the case of bolls from which only full grown larvae are known to emerge similar measurements gave an average of .8 mm. with a range of .75 to .87 mm. An unusually small exit hole in the carpel of a boll discovered in one other instance measured .33 mm., indicating a possible exception to the rule in the emergence of a second stage larva. After emerging from the interior the worm feeds on the leaf externally very much as does *B. thurberiella*, but a preference for the outer margins is shown and most of this feeding is on the leaves occurring low on the plant. In this respect *B. gossypiella* resembles the apple Bucculatrix (*B. pomifoliella* Clemens).[6]

The larvae which enter the carpels of the bolls find the most favorable conditions for their development and as already stated complete their larval growth before coming to the surface. Fortunately the larvae in the carpels do not penetrate the inner wall into the interior of the boll. At first they circle around near the point of entrance and then wander away for some distance eating a gradually enlarging irregular tunnel of the blotch type. Moulted head shields of two sizes have been found in the frass in such tunnels. In ten instances the distances from the entrance holes to the emergence holes in carpels of bolls ranged from 1 to 5.5 mm. averaging 3.1 mm. An exceptional instance was noted where the distance was 7 mm.

The larvae in the stem prefer to feed in the succulent parts just outside of the woody tissue but frequently penetrate woody stems to the pith. In one instance a live last stage larva emerged from a lot of woody cuttings ranging from 3/16 to 6/16 inches in diameter and although stunted in size developed into a perfect adult.

Molting Cocoons and Pupating Cocoons. Those larvae which emerge from their burrows at the end of the second stage spin molting

[6]Bul. 213 Cornell Exp. Sta. p. 73.

cocoons closely resembling those made by *B. thurberiella* and *B. pomifoliella*. These molting cocoons are commonly found on stems, usually in depressions or in scars left by fallen leaves, squares or bolls, comparatively few occurring on leaves. Two typical molting cocoons measured 3 by 1.6 mm. and 4 by 2 mm. respectively. The pupating cocoons are in general form typical of the genus Bucculatrix but the method of construction has not been observed.

The pupating cocoons are very difficult to find even on plants heavily infested with the larvae. On October 16 in an effort to secure more definite information in regard to the locations preferred by the larvae for spinning cocoons, an examination was made of 10 dry leaves picked from the ground under heavily infested plants, 10 mature green leaves, 10 immature green leaves and 10 green bolls from lower branches. On the dry leaves 10 molting cocoons and two pupating cocoons were found, seven molting cocoons were found on each lot of green leaves and no pupating cocoons, while on the green bolls only two molting cocoons were found. In a later examination in the same cotton field 3 pupating cocoons were found on one dry leaf. No pupating cocoons were found on the cotton stalks in a special search of 5 minutes, and none were found in crevices in the ground.

The "palisades"[7] or upright threads placed by the larva in an ellipse surrounding the place selected for constructing the pupating cocoon numbered, in four instances, 30, 31, 32 and 33 respectively.

Character and Amount of Injury

Wherever the newly hatched larva enters the plant tissue it first feeds close to the epidermis and a deep reddish surface spot gradually develops surrounding the entrance hole which is covered by the egg shell. This spot is at first more or less circular in outline but as it enlarges it becomes more irregular. Infested leaves show these discolored areas along the veins and as blotches on the leaf blade. The spots on the stems are usually more or less elongated longitudinally with the stem. Where two or more eggs are deposited close together the spots coalesce and in the case of the boll when three eggs are deposited within a radius of 1/8 inch the feeding of the three larvae usually results in the drying out and splitting of the carpel in a characteristic manner. Two larvae sometimes cause similar injury.

A normal cotton plant is able to support a large number of larvae of the cotton Bucculatrix without appreciable damage to any parts except

[7]Slingerland and Fletcher, Ibid.

the bolls. The ends of the growing shoots frequently show stunting late in the season as a result of the attack but fortunately the insect does not as far as observed increase to destructive numbers until after the first of September, when such stunting is of little or no importance. The bolls suffer considerable damage but even these parts may support large numbers of the larvae without appreciable effect. On the other hand the attack by as few as five larvae at the tip of a young boll may cause its complete destruction. The following data show the results recorded in one instance in the Yaqui Valley where an examination was made of 20 green bolls all larger than ¾ inch in diameter picked at random:

Condition	No. of bolls	Aver. No. of worms	Largest No. of worms	Smallest No. of worms
Practically uninjured........	8	6.3	11	4
Lint slightly stained...... ..	7	10.5	27	6
Lint badly stained......... ..	5	13.3	24	5

The average number of worms per boll for the 20 examined was 10.4. Fortunately the slight staining of the lint, which may cause a cotton grower much apprehension as to the extent of the damage, usually disappears soon after the bolls open. Direct sunlight hastens the bleaching-out process. It is only those bolls which are classed as badly stained and those which are so severely damaged they do not open normally that represent a loss. Some of those which appear to be badly stained are not necessarily a complete loss, as for instance when one lock in four is damaged in this way and the other locks open normally. The lot of 20 bolls referred to in the table did not include any of the partially opened and deformed bolls such as shown in Plate 15 which constituted not less than 10 per cent of all the bolls present in the field at the time. The total loss in this instance was estimated at approximately 35 per cent.

The damage from the cotton Bucculatrix in the Yaqui Valley is usually between 10 and 30 per cent. The damage may be held to the minimum under the prevailing conditions it is believed, by avoiding too early planting which gives the insect an opportunity to establish itself in the field and multiply early in the season before climatic conditions are favorable for the development of the cotton plant. In that locality April and May appear to be more favorable for cotton planting than February or March from the standpoint of control of the two leading cotton pests, the boll weevil (*Anthonomus grandis* Var.)[8] and the cotton Bucculatrix. If future investigations confirm this tentative conclusion

[8]Jour. Econ. Ent. Vol. 14, pp. 373–374.


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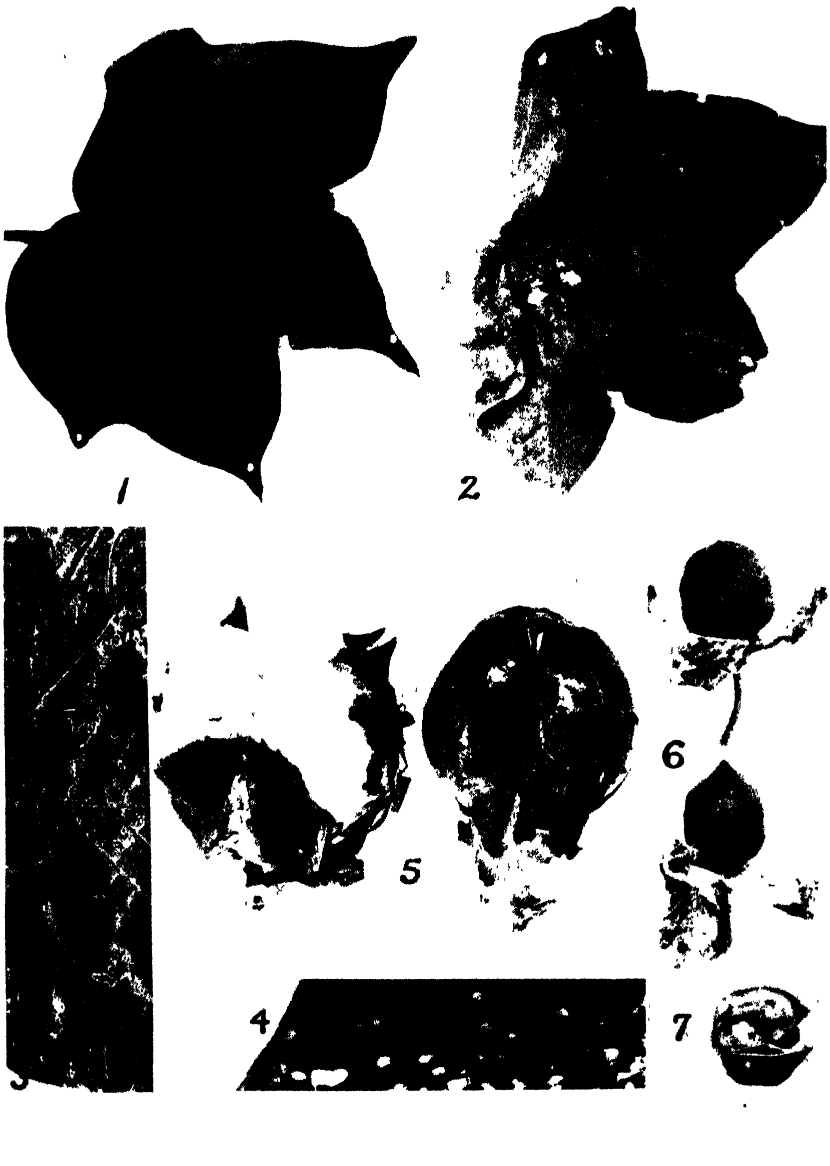
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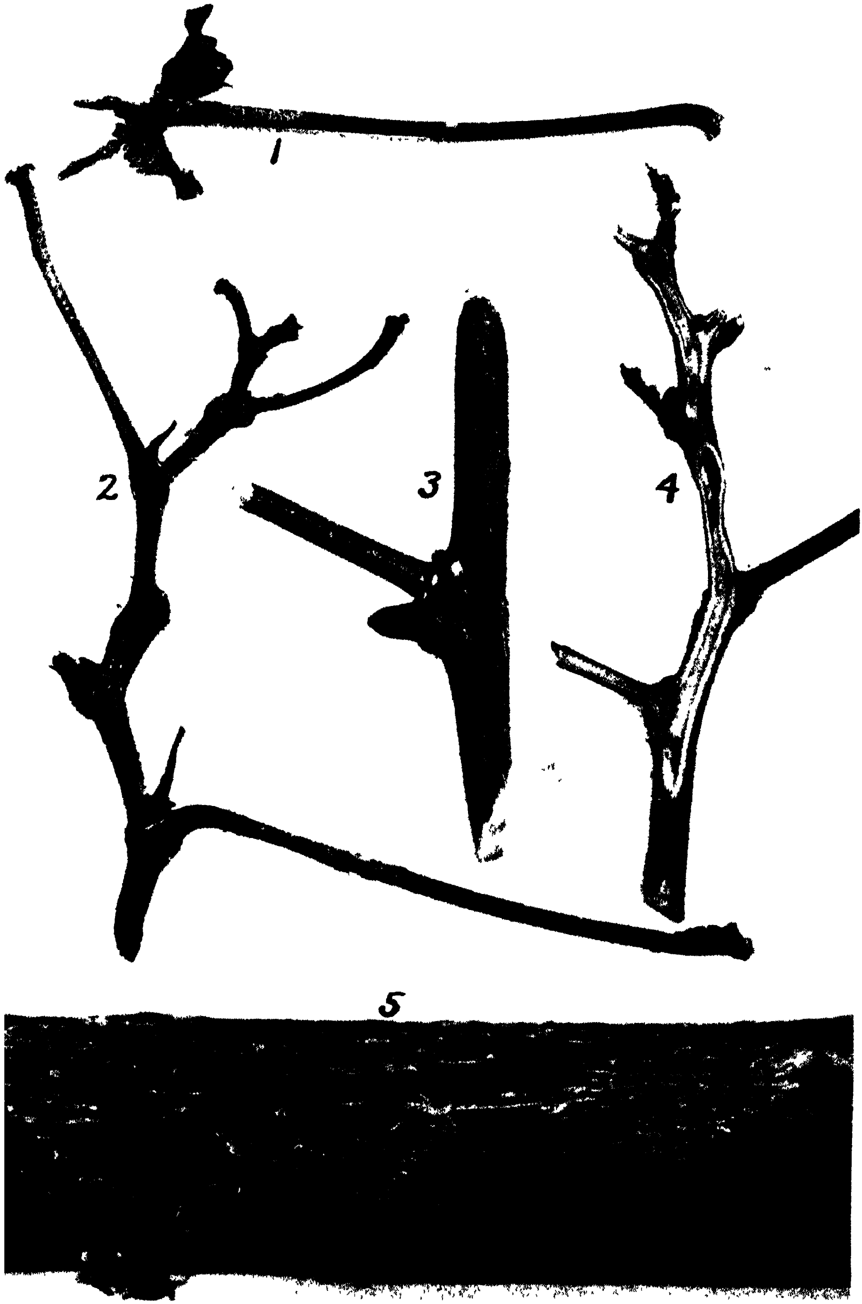

an effort will be made to secure a government regulation for the protection of the cotton industry prohibiting the planting of cotton before April 15 and requiring the destruction of cotton stalks before January 15 or other specified dates.

Dissemination

As is the case with its relative *B. thurberiella*, the cotton Bucculatrix has shown remarkable ability to spread within its habitat and to find single isolated cotton plants as well as fields of cultivated cotton, even though located several miles from known sources of infestation. In view of the small size and weak flight of the adult, this may indicate the existence of another food plant than cotton but no such plant has as yet been discovered.

Seed cotton may occasionally carry live larvae or pupae from the field to the gin, but it is hardly conceivable that a live Bucculatrix in any stage could survive the ginning process and be carried with cotton seed to an uninfested section. Baled cotton would be even less likely to serve as a conveyance for the pest in a live state.

The northern limit of the cotton Bucculatrix is believed to be the vicinity of Hermosillo in the state of Sonora. If the insect has the same capability for spreading north of this point as it has shown in southern Sonora it should find no difficulty in extending its range 120 miles north to the vicinity of Magdalena where a small acreage of cultivated cotton was grown in 1927. Magdalena is about 50 miles south of the international line and about 70 miles south of the nearest cotton growing district of the United States. Probably no wild cotton of the genus *gossypium* grows perenially within 75 or 100 miles of the international line but the hardy Arizona wild cotton, *Thurberia thespesiodes*, undoubtedly grows in many places in this region, judging from its known distribution north of the international line. Whether or not the Arizona wild cotton is a food plant or may serve as such and the reasons for the limited distribution of the cotton Bucculatrix in northern Sonora are interesting and important problems regarding this species which remain to be solved.

EXPLANATION OF PLATES

Plate 14. Work of *Bucculatrix gossypiella* Morrill on cotton: 1, Woody cotton twigs infested with larvae; 2, Cotton squares with bracts infested; 3, Bolls with infested carpels, emergence hole of larva shown near tip of boll at right; 4, Tangential section cut off from infested cotton boll showing larval burrows; 5, Infested boll opened to show discoloration of inside of carpel and damaged lint above at right; 6, Inner side of carpel of infested boll showing discoloration due to work of larvae; 7, Infested boll sectioned near base; 8, Infested boll sectioned near tip.

PLATE 15. Work of *Bucculatrix gossypiella* Morrill on cotton: 1, Lightly infested leaf showing mines of blotch type; 2, Heavily infested leaf showing severe damage to main ribs and adjoining parts of leaf blade, also slight damage near outer margins by feeding of larvae on surface; 3, Part of cotton leaf showing typical mines of young larvae of *Bucculatrix thurberiella* Busck; 4, Surface feeding of *B. gossypiella* on cotton leaf; 5, Bolls of cultivated cotton showing typical effects of excessive infestation by *B. gossypiella;* 6, Bolls of *Gossypium davidsonii* with carpels infested, spot with egg shell on boll above, emergence hole shown in boll below; 7, Same with epidermis removed to show burrows inside of carpel.

PLATE 16. Work of *Bucculatrix gossypiella* Morrill on cotton: 1, Dry leaf with all except fragments of blade removed to show damage to end of petiole and to leaf veins; 2, End of cotton branch showing stunted growth and gall-like swellings resulting from heavy infestation of woody parts; 3, Section of cotton stem showing cracked epidermis along course of larval burrow, also showing two moulting cocoons attached near center of figure; 4, End of cotton branch cut to show work of larvae, with burrows penetrating woody tissue to the pith; 5, Infested cotton stem greatly enlarged to show external effects of larval infestation.

Scientific Notes

An Infestation Index for Fruit Pests. The failure to note the relation of a crop infestation as determined on a percentage basis to the actual pest population of the fruit producing area has rendered valueless for criterion purposes the results of many excellent studies on pest control. In the case of the walnut codling moth the crop infestation will show the losses from year to year but it will not show with a similar degree of accuracy the variation of the moth population from year to year. Such yearly variations as well as variations between units or localities during the same year cannot be determined by means of the crop infestation alone. An index of the populations of a cultural unit, however, may be derived from the percentage of crop infestation by multiplying the average yield per acre by the per cent of infested fruit. The number thus obtained would represent the pest population for the unit under consideration. During favorable seasons as in 1925 the average yield of full bearing walnut orchards in the Saticoy district is 2,000 pounds per acre. Last year the average yield dropped down to 800 pounds per acre. If, for example, the moth population in this district for the last two years is represented by the index number 200 then the degree of crop infestation in 1925, would have been ten per cent (10%) and in 1926, twenty-five per cent (25%).

STANLEY E. FLANDERS

The orange maggot, *Anastrepha ludens* Loew, has been found in the principal citrus growing section of Texas. About the first of April a few grapefruits which came from the Lower Rio Grande Valley were found to contain some suspicious looking maggots. From these were reared four females and three males of the fruit fly, *Anastrepha ludens* Loew. Verification of the determination has just been received from Prof. J. M. Aldrich of the U. S. National Museum. In the meantime a brief survey to determine the distribution of the pest has been made. It is apparently well established, maggots being found in old and spoiled fruit of groves at Brownsville, La Feria, Mercedes, Weslaco, Donna, McAllen, and Mission. Practically all of the good fruit had been picked and sold before the presence of the insect was suspected. The only source of material for examination was that found under the trees and this for the most part was in a rotten or decaying condition. Although the orange

maggot is widely distributed in the Lower Rio Grande Valley the presence of the pest has only just begun to be suspected by a few of the growers. Temperatures below freezing are supposed to be very detrimental to this insect, but the past winter was unusually mild. The growers are being advised to thoroughly clean their groves of all fallen or decayed fruit, and to completely burn it with oil or soak it in oil until all maggots which may be present are killed.

F. L. THOMAS

Non-arsenicals for Grasshopper Control. Dusting with non-arsenicals for grasshopper control was tried out at the Sacramento field station, Sacramento, California, in 1926, with caged grasshoppers of the second and third instars. Check cages were used in each experiment. All cages were given fresh alfalfa at the beginning of the experiment. Sodium fluoride and sodium fluosilicate were mixed with both hydrated lime and gypsum at the rate of 1–5, 1–10, 1–15 pounds and dusted with a hand duster.

On June 5, with a temperature of 109° F., the following results were obtained.

Exp. No.	Poison	Inert Material	Time of application	No. hoppers used	No. hours before kill	Per cent killed
1	1 lb. Na. fluoride	5 lbs. hydrated lime	10 a. m.	100	3–4	100
2	1 " " "	10 " " "	" "	"	" "	98
3	1 " " "	15 " " "	" "	"	" "	96
4	1 " " "	5 " gypsum	" "	"	" "	100
5	1 " " "	10 " "	" "	"	" "	100
6	1 " " "	15 " "	" "	"	" "	100
7	1 " " fluosilicate	5 " hydrated lime	" "	"	" "	100
8	1 " " "	10 " " "	" "	"	" "	100
9	1 " " "	15 " " "	" "	"	" "	100
10	1 " " "	5 " gypsum	" "	"	" "	100
11	1 " " "	10 " "	" "	"	" "	100
12	1 " " "	15 " "	" "	"	" "	100

As seen from the above table, positive results at all dilutions were obtained by using either of the poisons. However, additional experiments, with temperatures of 89° F. and 96° F., gave negative results.

With the good showing made by these poisons under high temperatures, further experiments will be conducted with the hope of perfecting their use in major field control of Orthoptera.

C. C. WILSON, *U. S. Bureau of Entomology, Sacramento, Calif.*

THE ROCKY MOUNTAIN CONFERENCE OF ENTOMOLOGISTS

The Fifth Annual Meeting of the Rocky Mountain Conference of Entomologists will be held in Pingree Park, August 15 to 20. Pingree Park is a beautiful mountain park about 50 miles west of Fort Collins, at an altitude of 9,000 feet. Besides the regular program, which will be announced a little later, time will be available for collecting under these mountain conditions and for recreation. Part of the program will be in the form of symposiums. Advance information on the attendance makes

the following subjects seem appropriate: "The History of and Recent Developments in Economic Entomology," and "Problems in Apiculture." Transportation from Fort Collins to the Park, and accomodations, including meals, are provided at actual cost. Members of the family are cordially invited. All that have an opportunity to attend are urged to notify the secretary at once. Detailed information as to the arrangements will be sent to all interested.

GEORGE M. LIST, *Secretary, Rocky Mountain Conference of Entomologists, Colorado Agricultural College, Fort Collins, Colorado.*

SPRAY RECOMMENDATIONS FOR CODLING MOTH CONTROL FOR WASHINGTON 1927

Prepared by Representatives of the Washington State Experiment Station, the Federal Bureau of Entomology and the Washington State Department of Agriculture.

1. The severity of codling moth infestation in the state of Washington depends on length of growing season, degree of infestation the previous year and temperature at the time of emergence of the moth. Hence, such infestation varies in intensity in different districts and in different orchards.

2. Within a single district orchards vary in exposure, density of tree growth, type of cultivation, (whether cover crop or clean culture) and type of soil. All of these factors affect the development of the codling moth.

3. Because of these variable factors, specific spray recommendations cannot be given for an entire state or district. The spray program, while based on general principles, must be worked out in detail for each individual orchard.

4. The general principles are here outlined for the guidance of the grower.

(A) *Spray Treatment*

1. Arsenate of lead is the only known insecticide that is practical and effective in codling moth control.

2. Oil and other insecticides must be considered either ineffective or in the experimental stage. Do not use them except for experimental purposes.

3. The time of application and number of sprays to be used will vary in different orchards and in different localities and should be determined by each individual grower.

4. Major efforts for codling moth control should be directed toward first brood elimination.

5. The calyx spray should be applied when approximately 80% of the petals are off and before the calyx lobes have closed. Experimental evidence shows that this spray is important and should not be omitted.

6. The cover sprays should be timed carefully by the use of moth traps placed well up in trees away from packing sheds or other buildings. The first cover spray should be completed within ten to twelve days after moths are caught in the traps. If thermometers are available, temperature records should be taken as soon as first moths are caught in traps. If the temperature is 60 degrees at dusk, eggs will be laid and the first cover spray should be on the trees within ten to twelve days.

7. Cover sprays should be applied every ten days in severely infested orchards. In high altitudes or isolated orchards, having light infestation, one or possibly two cover sprays may suffice.

8. Cover sprays for first brood worms can stop ten days after moths practically cease to enter traps. This usually comes five to six weeks after the first moths appear.

9. Second brood sprays:
If there is an average of three to five worms per tree by July 1 or if moth traps show an increase in number of moths caught after July 1, one or more sprays for second brood should be applied.

10. The use of lead arsenate at the rate of 1 lb. to 50 gals. of water is usually sufficient. If a heavier dosage is used, do not use more than 1-½ to 50, and apply only in first and second cover.

11. BE THOROUGH IN SPRAYING, COVER EVERY PORTION OF THE TREE AND GIVE SPECIAL ATTENTION TO THE TREE TOPS, SINCE THAT IS WHERE THE EXTRA FANCY APPLES GROW AND WHERE MOST OF THE EGGS ARE LAID. TIMELINESS AND THOROUGHNESS CANNOT BE OVER-EMPHASIZED.

(B) Supplementary Treatments

1. Destroy all overwintering larvae in warehouses, apple boxes, packing sheds and other buildings. Avoid promiscuous transportation of infested apple boxes from one orchard to another.

2. Scrape rough bark from trees and burn to destroy overwintering larvae hibernating under the bark. This should be done to a depth of one to two inches below the ground.

3. Place moth traps well up in trees just before calyx spray is given, to catch the adult moth. Traps of this kind catch many moths before eggs are laid.

4. Band trees June 1 and examine every ten days. Rough barked trees should be scraped before banding. The bands will catch approximately 45% of the worms that leave the apples.

5. Fruit should be thinned to break clusters and to remove wormy fruit. This should be destroyed and not buried.

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(Signed March 12, 1927)

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1927

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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Charles P. Lounsbury, born in New England, gaining his inspiration from the elder Fernald, was graduated from the Massachusetts Agricultural College in 1894 and became Government Entomologist of the Colony of the Cape of Good Hope in July 1895, later becoming the senior official entomologist in South Africa. He has completed thirty-two years of service in the employ of a sister nation and has made a record which commands the admiration and respect of all. We learn through the South African press that he has retired and it is gratifying to note the justly high appreciation in which he is held. When he began, he was the only official entomologist in South Africa, now there are twenty-five in the Union, five in Southern Rhodesia and one in Portuguese East Africa—concrete testimony to the soundness of the work of our friend and colleague. His first work was with the fruit growers and it was through his efforts that adequate quarantine measures were adopted. He demonstrated the rôle of the tick in the transmission of certain animal diseases and the value of arsenite of soda for the destruction of ticks. A pioneer entomologist in that section of the world, he built wisely and well. His American friends deeply regret his retirement and trust that it means a well earned period of comparative ease and pleasure in his adopted country.

Reviews

La Vie des Termites by MAURICE MAETERLINCK, 217 pp., E. Fasquelle, Paris, 1927.

This book aims to do for the termites what the author's celebrated book on bees did for the other form of colonial life. To a considerable degree this has been accomplished, but it is evident that the author has less personal familiarity with termites than he had with his beloved bees. Reference is made to a considerable literature, including things as late as Cleveland's work on the intestinal protozoa. One looks for philosophy in all the writings of Maeterlinck, and in this book again appears his speculations on the government of colonial insects. In the years that have intervened since he wrote his bee book, the author seems to have found it less possible to settle these problems offhand. It is greatly to be hoped that an English translation will soon make this book more generally accessible.

E. F. PHILLIPS

The Ant People by HANS HEINZ EWERS, 323 pp., illustrated, Dodd Mead and Co., New York, 1927. Translated from German by C. H. Levy.

This is a popular book purporting to put information about the ants into such form that the layman can understand it. The burden of the book is a denunciation of the "pedantic scientists" who refuse to write so that ordinary humans can understand them. The author claims to have "poked his nose into ant nests in every land," but there is considerable evidence that most of his poking has been among the writings of those whom he so delights to belittle. His personal observations appear to be insignificant and superficial. The book will amuse entomologists, except possibly those who specialize in ants. It would appear that the author had in mind to do for ants what Maeterlinck has done for bees and termites: if this were his ambition he failed. The English translation is illustrated from the works of the derided pedantic scientists, some of them being used with amusing error.

E. F. PHILLIPS

Current Notes

Mr. J. G. Sanders of Philadelphia visited New Haven, Conn., and Providence, R. I., on May 8.

In March a shipment of 20,000 Tiphia cocoons from Assam, India, arrived at the Japanese Beetle Laboratory, Riverton, N. J.

Professor William Lochhead, Professor Emeritus of Entomology and Zoology, MacDonald College, McGill University, died March 26, in the sixty-third year of his age.

Mr. H. F. Barnes, research scholar of the Ministry of Agriculture, London, England, visited the Gipsy Moth Laboratory at Melrose Highlands, Mass., on February 8.

Mr. H. C. Hallock, of the Japanese Beetle Laboratory staff, recently spent three days at the U. S. National Museum studying Muscoid flies with Dr. J. M. Aldrich.

Mr. L. W. Brannon, Bureau of Entomology, returned to Birmingham, Ala., March 16, from his temporary assignment with the Federal Horticultural Board, scouting for the pink bollworm.

Dr. W. R. Thompson and Mr. K. W. Babcock plan to leave shortly for Paris to confer with American agricultural officials in regard to the European corn borer.

Mr. W. N. Keenan, of the Entomological Branch, delivered an address on "The Warfare against Foreign Insect Pests," over the radio from station CNRO, Ottawa, on February 21.

Professor George A. Dean, Manhattan, Kansas, will serve as consulting entomologist for the newly formed Millers' Export Inspection Bureau, an organization to insure flour from insect infestation.

For the present, Mr. L. H. Worthley will be located in Toledo, Ohio, with headquarters at 615 Front Street, in charge of control operations against the European corn borer.

Dr. Philip Garman gave an illustrated address on April 5, before the New York Entomological Society, on the work of the Entomological Department of the Connecticut Agricultural Experiment Station.

Mr. Neale F. Howard of the Bureau of Entomology, and Dr. D. M. De Long, Professor of Entomology, Ohio State University, recently visited the southeastern United States to study bean insects.

Messrs. R. W. Moreland, V. V. Williams, W. A. Stevenson, G. L. Smith and G. L. Garrison of the Arizona weevil force at Tucson, Ariz., have recently been transferred temporarily to the Federal Horticultural Board.

Dr. F. H. Lathrop and Mr. C. B. Nickels, of the Bureau of Entomology, have returned to Cherryfield, Maine, to resume the blueberry maggot investigations, after spending the winter in Washington, D. C.

On February 16, Mr. E. R. Van Leeuwen addressed the Century Club of Philadelphia, and on March 2, the Rotary Club of Rahway, N. J , on "Control Measures for the Japanese Beetle."

Dr. Grace H. Griswold of Cornell University visited at New London, Conn., for a few days early in April and called at the Agricultural Experiment Station, New Haven, on April 6.

At a meeting of the Eastern Plant Board held in New York City, May 2, the following entomologists were present: T. J. Headlee, E. N. Cory, W. C. O'Kane, W. E. Britton, R. H. Allen, L. B. Smith, and C. C. Hamilton.

Dr. Henry Fox, Japanese Beetle Laboratory, Riverton, N. J., visited the Boyce-Thompson Institute, Yonkers, N. Y., in February to inspect equipment and to consult with specialists in regard to contemplated lines of investigation.

Mr. L. S. McLaine, Entomological Branch, gave an address on "The Biological Control of the Spiny Cactus in Australia," before members of the Entomologists' group of the Professional Institute at Ottawa, on April 7.

According to *Science*, Dr. C. Montague Cooke, Jr., has been appointed chairman of the directing committee which has recently been organized in Honolulu to make an entomological survey of the countries bordering on the Pacific.

Dr. Philip Luginbill and Mr. Blanchard of the Monroe, Mich., laboratory, visited the Chatham, Ont., laboratory recently, to secure breeding stock of the corn borer parasite *Exoristes* and to observe the technique followed in rearing this species.

Mr. F. W. Poos, entomologist of the Virginia Truck Experiment Station, Norfolk, Va., visited the Bureau of Entomology, Washington, on March 16 to discuss studies on the potato tuber moth which he is conducting for the State of Virginia.

Professor Roger C. Smith was awarded $300.00 by the National Academy of Sciences for the study this summer of Neuroptera types in the Museum of Comparative Zoology at Harvard University.

Dr. George G. Atwood, Director, Bureau of Plant Industry, State Department of Agriculture, Albany, N. Y., reached the maximum age of retirement March 31, and his assistant, Mr. B. D. Van Buren, has been appointed to succeed him as Director.

Mr. L. F. Steiner, who recently received his master's degree from Ohio State University, has joined the Department of Entomology of the Purdue Agricultural Experiment Station and will undertake an investigation of the codling moth in southern Indiana.

Science announces that the one thousandth meeting of the Jugatae, the entomological society of Cornell University, will be held on May 28, and a celebration is planned to which all of its old members have been invited.

Mr. A. G. Dustan of the Entomological Branch broadcast an address on "The Control of Insects by Disease," from radio station CNRO, Ottawa, on March 7, as part of a program prepared by the Professional Institute of Civil Service.

Mr. J. L. King, on April 14, and Messrs. L. B. Smith and C. W. Stockwell on April 25, visited New Haven, Conn., to confer with W. L. Slate and W. E. Britton regarding proposed work on the Asiatic beetle and the Japanese beetle.

According to *Science*, Professor A. L. Melander of the City College of New York has been appointed to the staff of the Biological Laboratory at Cold Spring Harbor for the coming summer to aid in the course in field zoology.

Dr. L. B. Soliman of the Plant Protection Section, Ministry of Agriculture, Cairo, Egypt, has recently visited the United States, and in February conferred with Dr. P. W. Mason on aphid problems. Dr. Soliman intends to study the aphid fauna of Egypt.

Professor Mario Bezzi, the authority on Diptera of the world, who was recently appointed Professor of Zoology and Director of the Zoological Museum of the Royal University of Turin, Italy, died suddenly, January 14, at the age of fifty-nine.

On February 11, at Albany, N. Y., Messrs. A. F. Burgess, S. S. Crossman, and H. L. Blaisdell attended a meeting called by H. L. McIntyre, of the New York State Conservation Commission, to consider plans for the coming season in the gipsy moth campaign.

Mr. G. A. Ficht, who has pursued graduate work at the Iowa Agricultural College, Ames, Iowa, has recently joined the Department of Entomology of the Purdue Agricultural Experiment Station, Lafayette, Ind., and will be engaged in research on the European corn borer.

Mr. J. N. Knull, of the Bureau of Plant Industry, Harrisburg, Pa., visited the Section of Insects, U. S. National Museum, on March 29 and 30, and examined types of Buprestidae and Cerambycidae in the collection, especially the species which were described by Casey.

According to *Science*, Dr. L. O. Howard has been elected an honorary member of the New York Entomological Society in recognition of his many and great services to entomology, especially as Chief of the Bureau of Entomology of the U. S. Department of Agriculture.

Mr. Norman Criddle gave an illustrated address on "Wild Life in Manitoba" before a meeting of the Entomologists' Group of the Professional Institute, at the home of Mr. H. G. Crawford, on March 9. Mr. Criddle left Ottawa on March 10 to return to Treesbank, Manitoba.

Mr. K. E. Stewart, M.Sc. (McGill) has been appointed to the position of Junior Entomologist, Entomological Branch, to study shade and forest tree insects in the Prairie Provinces. Mr. Stewart, who is at present in Ottawa, will shortly proceed to his headquarters at Indian Head, Sask.

Dr. E. A. Back, Bureau of Entomology, spent February 23 in Hartford, Conn., consulting with a large brush-manufacturing concern regarding its insect problems. Every firm which makes brushes and deals with bristles imported from China is confronted at times with serious problems of that kind.

Mr. C. H. Hadley, Director, Bureau of Plant Industry, State Department of Agriculture, Harrisburg, Pa., resigned, effective May 1, and has accepted a position in the Bureau of Entomology and will be engaged in European corn borer control work with headquarters at 615 Front St., Toledo, Ohio.

Mr. G. M. Stirrett, of the Chatham, Ont., Laboratory, Entomological Branch, visited Arlington, Mass., Silver Creek, N. Y., Wooster, Sandusky, and Oak Harbor, Ohio, and Monroe, Mich., from March 10 to 20, in connection with a careful study of the conduct of European corn borer investigations in the United States.

Mr. H. G. Crawford addressed the Quinte Seed Growers' Association at Belleville, Ont., on March 19, and farmers' meetings at Dundee, Elgin, Hinchinbrook, Franklin, Huntingdon, Havelock, and Hemmingford, Que., during the last week in March, on the European corn borer, in connection with the control campaign against this insect.

Mr. M. B. Dunn, Entomological Branch, arrived in Ottawa from Welcome Lake, Ont., on April 7, after having spent the winter months in the forest carrying out a study of the growth rings of spruce and balsam to determine the loss of annual increment due to recent budworm injuries.

Mr. A. B. Baird, of the Chatham, Ont., Laboratory, Entomological Branch, visited the United States Corn Borer Laboratory at Arlington, Mass., March 29 to April 1, to secure a supply of new parasite breeding material, made available for liberation in Canada by the kind coöperation of the United States authorities.

According to *Science*, at the invitation of the American Association of Economic Entomologists and the Entomological Society of America, the fourth International Congress of Entomology will be held at Ithaca, N. Y., probably the third week of August, 1928. A preliminary program will be issued in the near future.

Dr. Stanislaw Minkiewicz, of the Institute of Agricultural Research, Pulawy, Poland, is spending several weeks in the Division of Insects, U. S. National Museum, looking over various groups of insects that are injurious to Polish crops. He is also interested in methods of handling collections and keeping track of literature.

Mr. Arthur Gibson, Dominion Entomologist of Canada, visited the Japanese Beetle Laboratory at Riverton, N. J., in February, where he spent two days in conference with members of the laboratory staff. Previous to his stop at Riverton, Dr. Gibson attended the meeting of the New Jersey Mosquito Extermination Association at Atlantic City.

Mr. W. H. White, of the Bureau of Entomology, recently visited Sanford, Fla., to discuss the celery leaf-tyer investigations with Messrs. Ball, Boyden and Stone, and returning to Washington, conferred with Messrs. Thomas and Reid at Chadbourn, N. C., regarding work in progress on the strawberry weevil and the seed corn maggot.

Dr. E. A. Chapin, of the U. S. National Museum, spent March 3, 4, and 5 in Philadelphia, studying types of Coleoptera, especially those belonging to the genus *Ptilodactyla*. Since his return to Washington he has completed a short paper on *Ptilodactyla*, describing new species, one of which is injurious to roses in greenhouses.

Mr. P. W. Fattig, curator of the museum of Emory University, Atlanta, Ga., recently spent a week in Washington, consulting with the specialists in the Section of Insects, U. S. National Museum, getting many specimens of insects determined, and arranging to send other specimens as a gift to the Museum collection and for determination.

Professor W. C. O'Kane visited New York City April 2, and also was the chief speaker at a meeting of the Connecticut Branch of the Alumni Association of the University of New Hampshire at Bridgeport in the evening. Dr. W. E. Britton is President, and Professor J. A. Manter, Secretary-Treasurer, of the Connecticut Branch.

Shipments from Europe to the United States of parasites and parasitized larvae of *Pyrausta nubilalis* are steadily being made. For the present fiscal year to date, shipments have been as follows: *Eulimneria crassifemur*, 29,534; *Angitia punctoria*, 11,209; *Phaeogenes planifrons*, 17,017; *Microgaster tibialis*, 127,680; *Masicera senilis*, 1,652; parasitized larvae bearing various percentages of other species, 1,242,000.

The appointment of Mr. Arthur Gibson as Honorary Curator of Entomology in the National Museum of Canada, has been approved by the Hon. Charles Stewart, Minister of the Interior, and the Hon. W. R. Motherwell, Minister of Agriculture. This position and its duties will be additional to his position and duties as Dominion Entomologist in the Department of Agriculture.

Dr. F. C. Craighead returned to Washington February 23 from a trip to the Forest Insect Field Station at Palo Alto, Calif., where a conference was held February 9–16 on the control of forest insects in the West. In March Dr. Craighead visited Florida, Georgia, and North Carolina, to review the work of his division concerning the insects attacking pines in the Southern States.

Mr. Louis A. Stearns, Assistant Entomologist, New Jersey Agricultural Experiment Station, New Brunswick, resigned May 1 to accept a similar position with

the Ohio Agricultural Experiment Station, Wooster. He is located for the present at 713 Center Street, Ironton, Ohio, in charge of a recently established Fruit Insect Laboratory where investigations of the Oriental Peach Moth and Codling Moth will be conducted.

Mr. K. M. King of the Entomological Branch addressed meetings of Weed Inspectors at Saskatoon and Regina on March 1 and 15 respectively, and members of the Case Threshing Machine Company at Saskatoon on March 10, in connection with problems relating to insect pests. On March 15 he broadcast an address on "The Western Wheat-Stem Sawfly," from radio station CKCK, under the auspices of the Saskatchewan Farmers' Radio Farm School.

Dr. E. A. Schwarz has received several long letters from R. C. Shannon, giving an account of a collecting trip taken by Mr. Shannon and Dr. F. W. Edwards, of the British Museum, and their wives. They went into the southern part of the Andes, crossing into Chile and returning by rail to Buenos Aires. They report a very successful collecting trip, in the course of which they found many new species.

Mr. W. A. Ross, of the Vineland, Ont. Laboratory, Entomological Branch, who returned from a visit to Great Britain on February 8, visited a number of laboratories of entomology and plant pathology, and certain important fruit-growing districts in England and Scotland, during his brief sojourn there. During the course of these visits he had the opportunity of meeting many distinguished investigators and made a number of interesting and valuable observations.

Mr. W. Downes left Ottawa to return to Victoria on March 2. While at headquarters he visited Montreal and Quebec, February 12–18, to examine the collection of Hemiptera in the Redpath Museum, McGill University, the George A. Moore Collection, and the Provancher Collection at the Quebec Parliament Buildings. En route to Victoria, Mr. Downes spent several days with Dr. Carl J. Drake of the Department of Entomology, Iowa State College, in connection with Hemiptera studies.

Mr. J. E. Graf, of the Bureau of Entomology, left Washington on February 3 to attend a conference in connection with the sugar-beet leafhopper problem at Ogden, Utah, February 9 to 10. From here he proceeded to the Pacific Coast, where he conferred with State officials and officials in charge of Bureau laboratories and returned to Washington March 14, via the South, after visiting a few of the Gulf Coast laboratories.

Dr. H. E. Ewing left March 16 for a trip to Texas, Arizona, New Mexico and Louisiana, to make field observations on scorpions. He hopes to determine some means of controlling the species which frequent dwellings, and to obtain material for the Museum collection. In Louisiana he hopes to obtain specimens of adult chiggers, so as to continue his experiments on their life history and habits, and plans to return to Washington early in May.

Mr. F. Nevermann, of Costa Rica, spent three days of the week of March 21 in Washington. While there he became acquainted with the various specialists in the Taxonomic Division, U. S. National Museum, examined the collections, and consulted about specimens which he had forwarded. Mr. Nevermann is a very good field observer, and has sent to the specialists interesting specimens of Coleoptera, and many ants and termites. He has a large collection of Costa Rican Coleoptera, which numbers about 5,000 species.

A series of lectures has been planned by the Graduate School Committee of the U. S. Department of Agriculture in order to foster a better acquaintance among the department personnel with the important phases of the work being done in the several bureaus. The first lecture in this series was an illustrated one by Dr. L. O. Howard on "Fifty Years of Economic Entomology," and was given on the evening of March 29, in the auditorium of the U. S. National Museum.

During December last Dr. A. C. Baker of the Bureau of Entomology went to Sacramento, Calif., as consultant on the citrus white fly campaigns contemplated in that State. After a method of procedure had been decided on, he visited the citrus regions in Southern California, and conferred with entomologists of various California institutions. Returning by the southern route, he spent some time at the laboratories in New Orleans and Orlando in order to review the projects under investigation, and reached Washington early in March.

Dr. J. M. Swaine has made arrangements for the transference of parasites of the larch sawfly from Manitoba to eastern Canada. It is also planned to collect and transfer *Phytodietes* parasites from spruce budworm outbreak areas in British Columbia to localities where there are similar outbreaks in Ontario and Cape Breton Island. The parasites will first be sent to Mr. A. B. Baird of the parasite laboratory at Chatham, Ont., before final distribution at various points in eastern Canada. Mr. Norman Criddle has undertaken to collect the larch sawfly parasites in Manitoba.

An artistically and effectively arranged exhibit showing the organization, functions, and work of the Entomological Branch was prepared under the direction of Mr. C. B. Hutchings in the Victoria Memorial Museum, Ottawa, during the latter part of March, at the request of the Deputy Minister of Mines. This exhibit formed part of an extensive exhibition demonstrating the activities of various departments of the Federal Government, and was opened on March 23, on the occasion of the annual Conversazione of the Professional Institute of the Civil Service. It was later thrown open to the general public and attracted more than 11,000 visitors.

The nineteenth annual meeting of the Quebec Society for the Protection of Plants was held at Macdonald College, Que., on March 30. The following papers were presented at the meeting by officers of the Entomological Branch: "The European Corn Borer Situation in Ontario and Quebec," by L. S. McLaine; "Notes on the Control of the Forest Tent Caterpillar," by J. J. de Gryse; "Notes on Some Barriers Used against Garden Slugs," by A. G. Dustan; and "The Household Mosquito, *Culex pipiens* L., and Its Control at Montreal," by C. R. Twinn and W. St. G. Ryan. In addition to the above officers, Messrs. C. E. Petch and W. J. Brown also attended the meeting.

Mr. R. T. Webber visited Washington during the week of February 7 and attended to various details in arranging for his foreign investigations. He sailed on the S. S. George Washington on February 19 for Cherbourg, France. After consultation with entomologists and government officials in France and several other European countries he will proceed to Hungary, to spend a short time with C. F. W. Muesebeck and R. C. Brown, at the Gipsy Moth Laboratory in Budapest, arranging to obtain parasites in Hungary for shipment to Melrose Highlands, Mass. He will then investigate the gipsy moth conditions in Italy, northern France, and Spain, for the purpose of sending natural enemies of this insect to the United States.

A corn borer train consisting of two cars was fitted up and run over the Pennsylvania Lines in northern Indiana from March 28 to April 9. A baggage car carried exhibits dealing with the life history of the European corn borer, and important methods of control. The second car was a passenger coach where motion pictures and illustrated lectures were given. Mr. G. A. Ficht accompanied the train throughout the trip and Prof. J. J. Davis was aboard for the first two days. This train, possibly the first exclusive insect train ever run, was operated by the Purdue Agricultural Experiment Station with the cooperation and assistance of the Pennsylvania Railroad Company, and aroused much interest.

Mr. T. E. Holloway attended the meetings of the International Society of Sugar Cane Technologists, held in Havana, Cuba, during the week of March 14. At the end of the meetings he visited the Cuba Sugar Club Experiment Station, which is under the auspices of the Tropical Plant Research Foundation, and conferred with D. L. Van Dine, Director, and C. F. Stahl and H. K. Plank, entomologists. The main station is at Baragua, but special attention was paid to the work being conducted by Mr. Plank at Jaronu on the control of the sugar cane moth borer. For most of the travel in Cuba advantage was taken of a special train provided by the Cuban Government to afford the delegates a tour of the island.

Messrs. T. R. Gardner and H. A. Jaynes visited Washington, February 15 to 19, where they conferred with Dr. A. L. Quaintance regarding the work of the Bureau in the Orient relative to parasites of the Japanese beetle. Mr. Gardner recently returned from Japan, where for three years he had carried on investigations relating to parasites of the Japanese beetle, and had shipped many parasites of that insect to the laboratory at Riverton. On April 5 he returned to Japan to resume this work for another period of three years. Mr. Jaynes has also recently returned from foreign service, having spent the last three years in China engaged in work on parasites of the Japanese beetle. On his trip back to this country he stopped for two weeks in England, where he examined type specimens of some of the parasitic wasps at the British Museum.

In the collection of the California Academy of Sciences, reports Dr. H. E. Burke, of the Palo Alto Forest Insect Field Station of the Bureau of Entomology, there are several specimens of the wood-boring beetle, *Trachykele opulenta* Fall., which were taken from a 1,200-year-old lightning scar in the wood of a "big tree," *Sequoia washingtoniana.* These specimens, says Dr. Burke, were collected at Giant Forest in the Sequoia National Park in California. When the tree was about 420 years old it was struck by lightning. The wood-boring beetle attacked the scar, and a brood developed in the wood. Some of the beetles failed to emerge and were hermetically sealed as new growth covered the scar. The beetles remained in perfect condition in the wood of the tree for 1,200 years, until the entomologist came across them. Careful comparison of these ancient specimens with modern specimens of the same species shows that there has been no material change in the species in the 1,200 years.

The third annual meeting of the Kansas Entomological Society was held at Lawrence, Kansas, April 14, 1927, with twenty-two members present. The day was spent in the presentation of papers and reports concerning research work in progress. Steps were taken to secure the publication of the proceedings of the society. A resolution was passed that the Society go on record as favoring a uniform building code in Kansas that will prevent termite injury. The meeting of the Society next year will be held in Wichita, Kansas, at about the time of the meeting of the

Kansas Academy of Science. New officers elected were Mr. Warren Knaus of McPherson, President; Dr. R. L. Parker, Manhattan, Secretary. The following were present: Professor Geo. A. Dean, Dr. Roger C.Smith, Professor J. W. McColloch, Dr. R. L. Parker, Professor Harry R. Bryson and Dr. Reginald H. Painter, Manhattan; Dr. Hazel E. Branch, Wichita; Mr. Lyle A. Stephenson and Mr. and Mrs. J. W. Blachly, Kansas City, Mo.; Mr. W. Knaus, McPherson; Mr. J. R. Horton, Mr. Warwick Benedict, Miss Kathleen Doering, Dr. H. B. Hungerford, Dr. Paul B. Lawson, Professor R. H. Beamer, Dr. P. A. Readio, Mr. Howard Deay, Mr. Charles H. Martin and Mr. E. P. Breakey, Lawrence, and Mr. Schenk, American Cyanamid Sales Company, New York.

The Boll Weevil Field Station of the U. S. Bureau of Entomology at Tallulah, La., was completely inundated in the great Mississippi flood. This is the headquarters for the Bureau's cotton insect investigations for the South and the Southwest, and includes five buildings. Water invaded the photographic laboratory and rose to within a few inches of the main floor of the office building. The aviation field of the station, some two miles northeast of Tallulah was all under water. This is the headquarters for all of the flying equipment used by the Bureau in all its crop dusting work in the South. The four planes were removed just in advance of the flood. The hangar is still standing though windows were broken by the rushing water. There does not appear to have been any great amount of damage to government property, though personal losses of the 20 station people may be considerable. The boll weevil experimental work will be delayed and certain phases made impossible this season. Communication with Tallulah was interrupted by the flood and its reestablishment is a matter of some uncertainty.

Horticultural Inspection Notes

Brown-tail moth scouting in Nova Scotia was completed for the season on March 26, a total of 19 nests having been found as compared with 77 found last year.

Mr. A. G. Harley has been transferred from Baltimore, where he has been stationed since June 1925, to Philadelphia, to assist in handling the work of the Federal Horticultural Board at the latter port.

Messrs. Arthur G. Lennox, William A. Ranck, and W. M. J. Ehinger were recently appointed Junior Plant Quarantine Inspectors in the Federal Horticultural Board. Mr. Lennox is stationed in New York, Mr. Ranck in Baltimore, and Mr. Ehinger in Philadelphia.

Mr. W. W. Wood, who has been stationed in New York, was transferred to Detroit about March 21 to take charge of the work of the Federal Horticultural Board at that port and at Port Huron, Mich.

The narcissus bulb quarantine, domestic, has just been revised by the Federal Horticultural Board and regulations (HB No. 203) issued which serve to explain a number of points in connection with the inspection and certification of domestic narcissus bulbs.

Mr. George Becker, in charge of the pink bollworm eradication work for the Federal Horticultural Board, was in Washington for a few days early in May for a conference relative to the progress of the work.

The Federal Horticultural Board has recently established a new station at Hidalgo, Texas, and Mr. J. M. Singleton, who was stationed at El Paso, Texas, was transferred to Hidalgo to take charge of the Board's work at the new port.

On March 9, inspectors of the Federal Horticultural Board found among the effects of a passenger from Barbados arriving on the steamship *Voltaire*, a package containing five pieces of sugar cane, one cassava, and one cotton boll. On examination of this material the cotton boll was found to contain six living larvae of the pink bollworm, *Pectinophora gossypiella*.

Mr. George B. Sudworth, dendrologist of the Forest Service and a member of the Federal Horticultural Board, died at his home in Chevy Chase, D. C., Tuesday, May 10, 1927. Mr. Sudworth was appointed a member of the Board in 1912, at the time of its creation, and had served continuously until the time of his death.

The National Plant Board met in Washington on May 12 and 13 to discuss a number of quarantine matters of importance. A joint meeting was held with the Federal Horticultural Board on the afternoon of May 13. The members of the Plant Board in attendance were Lee A. Strong, Wilmon Newell, W. C. O'Kane, W. A. McCubbin, R. E. McDonnald, S. B. Fracker, and Frank N. Wallace.

Mr. R. K. Beattie, until recently in charge of the Import Division of the Federal Horticultural Board, was transferred on May 1 to the office of Forest Pathology of the Bureau of Plant Industry, to take up work in connection with the securing of varieties of chestnuts immune to the blight disease. He will probably spend a considerable amount of time in the Orient on this work. Mr. Beattie has been connected with the Board since July, 1914, as Pathological Inspector.

The turnip gall weevil, *Ceutorhynchus pleurostigma*, has been recently intercepted by inspectors of the Federal Horticultural Board in two shipments of rutabagas arriving at New York from Holland. The shipments, made up of 3,560 bags, were refused entry and returned after a careful examination which showed that 2.3% of the roots were infested. This insect, which is not established in the United States, is reported to be a rather destructive pest of cabbage, cauliflower, Brussels sprouts, broccoli, turnips, rutabagas, and wild crucifers in Europe.

The West Indian sweet potato weevil, *Euscepes batatae* Waterhouse, has been intercepted recently in sweet potato tubers by inspectors of the Federal Horticultural Board at New Orleans, and Washington, D. C. The tubers intercepted at New Orleans originated in Brazil, while the insects collected in Washington came in tubers from Porto Rico. This insect is widely distributed in the West Indies and is also established in Brazil, Argentina, and in the Hawaiian Islands. Judging from the amount of injury caused in the tubers, this insect might become a serious pest if established in this country. From one small tuber examined, 44 insects were taken, and from another, 25 were removed.

Pacific Slope Notes

Mr. A. O. Larson, of the bean weevil investigations, Alhambra, Calif., spent the month of February in Washington, summarizing notes and reviewing literature.

On February 17, W. D. Reed, of the Dried-Fruit Laboratory, Bureau of Entomology, Fresno, Calif., gave an address on the general subject of entomology, at the monthly meeting of the Students' Agricultural Club of the Fresno State College.

Mr. Walter Carter, Twin Falls, Idaho, visited points in Oregon and California about the middle of March, conferred with Experiment Station officials and others regarding the sugar-beet leafhopper, and made preliminary plans for undertaking work in Oregon on this pest.

On February 10, Mr. E. A. McGregor appeared before a meeting of merchants and orange growers of Lindsay, Calif., and vicinity, and addressed them on the subject of the citrus thrips. The meeting was well attended and many questions were asked at its conclusion.

Notes on Medical Entomology

The Fourteenth Annual Meeting of the New Jersey Mosquito Extermination Association was held at Atlantic City, N. J., February 23–25, with about 150 delegates present.

According to *Science*, Dr. Francis M. Root, Associate in Medical Entomology at the School of Hygiene of the Johns Hopkins University, sailed on April 27 for Venezuela, where he will study the mosquitoes of the region, returning in September.

Mr. Eric Hearle visited Winnipeg on March 29, and delivered a series of public lectures on the life-history and control of mosquitoes. Mr. Hearle's addresses were given considerable newspaper publicity, as an organized campaign against Winnipeg mosquitoes is being planned under the leadership of Dr. H. M. Speechly.

Mr. C. R. Twinn, of the Entomological Branch, delivered an address entitled "Some Remarks on Canadian Mosquitoes and Anti-mosquito Activities," before the Entomologists' Group of the Professional Institute at Ottawa on February 18. The latter part of the address was illustrated by a series of colored lantern slides. Mr. Twinn addressed the members of the Gastronomic Club on the control of Ottawa's mosquitoes, on March 23, and broadcast a radio talk on "Mosquitoes and Their Control in Canada," from station CNRO, Ottawa, on April 11.

The State Legislature of Montana has recently appropriated $60,000 for the erection of a laboratory at Hamilton, for the State Board of Entomology, to be used in further studies of the Rocky Mountain spotted fever. A sum of about $25,000 per year for the next two years has been provided for carrying on the work on this important problem. The work is being conducted under an informal plan of cooperation between the United States Public Health Service and the Montana State Board of Entomology, the former being represented by Drs. R. R. Spencer and R. R. Parker, and the latter by Drs. W. F. Cogswell and W. J. Butler, and R. A. Cooley.

Apicultural Notes

Mr. James I. Hambleton gave a radio talk over Station WRC on April 27, on "The Honeybee," under the auspices of the Smithsonian Institute.

Recent visitors at the Bee Culture Laboratory included Prof. Francis Jager of the University of Minnesota, and C. L. Sams, Specialist in Beekeeping, of the North Carolina State College of Agriculture and Engineering.

On March 22, Dr. A. P. Sturtevant, in charge of the Intermountain Bee Culture Field Station, gave a radio talk in connection with the program broadcast by the American Honey Producers' League from Laramie, Wyo.

Mr. W. Herrod-Hempsall, Technical Adviser in Beekeeping, Ministry of Agriculture, of the British Government, has arrived in this country with his wife and son. He expects to visit the principal beekeeping centers in the United States and Canada.

Prof. L. F. Bertholf, of Western Maryland College, visited the Bee Culture Laboratory of the Bureau of Entomology on May 2 for the purpose of discussing plans preparatory to continuing during the summer his investigations on the light responses of the honeybee.

Miss Catherine Lucas, who has been studying the amoebae of insects at Johns Hopkins University under a postgraduate traveling fellowship from the University of London, is continuing this line of investigation at the Bee Culture Laboratory of the Bureau of Entomology.

Dr. L. R. Watson of Alfred, New York, formerly connected with the Bee Culture Laboratory of the Bureau of Entomology, gave a demonstration of his method of artificially inseminating queen bees at the Bee Culture Laboratory on April 30, before the members of the Maryland Beekeepers' Association, members of the Department of Entomology of the University of Maryland, and the members of the Bee Culture Laboratory.

Members of the Pan-American Conference on Standardization, meeting this week in the Third Pan-American Commercial Conference, visited on May 10 the exhibit and demonstration of the United States Standard Grades for honey prepared by the Division of Bee Culture Investigations of the Bureau of Entomology. This work was shown in connection with the exhibit of the Bureau of Agricultural Economics in the new Standardization Building. Considerable interest was manifested in this exhibit as a means of facilitating export and import trade in honey, and as a basis for international standardization as the Standard Honey Graders used in this work are now located in Berlin and London, as well as in the export ports of the United States and are also in use in New Zealand.

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PRELIMINARY NOTES ON THE DEPTH OF HIBERNATION OF WIREWORMS (*ELATERIDAE, COLEOPTERA*)

By J. W. McCOLLOCH, WM. P. HAYES and H. R. BRYSON[1]

ABSTRACT

Since little is known concerning the hibernation of wireworms which pass the winter in the larval stage under the surface of the soil any observations, however meager, are of value in working out the complete life history of these important, injurious insects. Preliminary studies carried on in Kansas consisted of a series of diggings mostly in uncultivated areas where wireworms, theoretically, are the most abundant. No great numbers were found during the two seasons in which the most intensive work was done. During these two seasons the average depth of those found was 7.7 inches in 1922–1923 and 10.1 inches in 1925–1926.

A feature of especial interest brought out by this study is that wireworms were frequently found above a depth of six inches even in mid-winter where they encountered much colder conditions than those deeper in the soil, some of which went down as far as 36 inches. From this it is evident that the frequent recommendation for control of fall plowing to expose the wireworms to the rigors of winter may have less value than is usually attached to such a farm practice.

INTRODUCTION

During the course of a study on the depth of hibernation of white grubs and May-beetles, the results of which are now in press, the writers had opportunity to make some studies on the depth of hibernation of wireworms. Since there are in the literature, few, if any, recorded observations on the hibernation of the larvae of Elaterid beetles it seems worth while to note the present results. The paucity of observations on the winter habits of soil-inhabiting insects is due, in part, at least, to the difficulty of studying the habits of insects which live within the soil. A still more important factor in the case of wireworms is the difficulty of making specific identification of the larvae which, on the whole, must be reared to the adult condition before satisfactory de-

[1]Contribution No. 357. Kansas Agricultural Experiment Station. This paper embodies some of the results obtained in the prosecution of project No. 100 of the Kansas Agricultural Experiment Station.

terminations can be made. It has been the writers' experience that a period of five or six years may elapse between the time of collection of some species and the date of maturity. Naturally, many specimens are collected which cannot be reared to the adult. Because of these difficulties the observations herein noted apply to wireworms as a class. However, it is well to note that, in the vicinity of Manhattan, Kansas, where these studies were made, the majority of adult specimens collected belong to the genera *Melanotus*, *Monocrepidius*, *Lacon*, *Agriotes* and *Ludius*.

METHODS

The present study was started during the winter of 1919-1920 and carried on at intervals when time was available. Emphasis was placed on the study of white grubs and for only three of the seasons between 1919 and 1926 were data collected on wireworm hibernation. All observations were made on soil removed inch by inch, by hand digging with a spade to depths varying from 14 to 48 inches. The size of the holes varied. During the winter of 1919–1920 five holes were dug, each of which was three feet square and only one wireworm was found during the season. No further wireworm observations were made until the fall and winter of 1922–1923 when a larger series of diggings was carried on. At this time 25 holes were sunk most of which were four feet square, a few however, were about six feet long, varying in depth from 14 to 48 inches. In each case digging was continued only as long as insects were being found. The intervening season, between 1922–1923 and 1925–1926 was unproductive as far as wireworms were concerned. During 1925–1926, however, the most extensive collections were made. At this time 38 holes were excavated each of which was two by three feet in area.

In each operation the soil was removed inch by inch and carefully sorted by hand for the insects. The number of wireworms found appears small, possibly because most of the digging was done in uncultivated areas on the higher uplands. However, the statement is common in the literature, that severe injury by these insects always follows the planting of crops on newly broken sod, which, if true, would lead one to look for the species in sod land, in order to find them in their natural state. Such locations probably afford more normal conditions than those of cultivated areas and one might expect in such places to find the greater number of individuals. Some observations, however, were made in lowland and sandy areas.

During the 1919-1920 season excavations were first made Oct. 24,

and none were made after cold weather had set in. The season of 1922–1923 studies were begun November 25 and were carried on throughout the winter until March 24. In 1925–1926 the first hole was dug November 20, and the last one March 20. The data secured during the two seasons, 1922–1923 and 1925–1926, in which the work covered the entire winter are probably more representative of average conditions.

Presentation of Data

During the fall of 1919–1920 only one wireworm was found in the five holes dug. This was taken in a hole dug around the base of a corn plant on Oct. 24. The depth at which it was found was between four and eight inches. Although this hole was sunk 20 inches, no other individuals were found. One of the other holes was in wheat stubble, another in bluegrass sod and the other two in ground overrun with bindweed.

The examinations of 1922–1923 were more productive. In all 18 wireworms were found in nine of the 25 holes dug. The greatest depth at which any individual was taken was 16 inches and the minimum depth was four inches with an average for the 18 of 7.7 inches. Most of these holes were in grassland; one was in a patch of sunflowers; one in an orchard; and another in grassland on a sand dune. It is of interest to note that the earlier diggings, Nov. 25, to Dec. 21, yielded specimens at depths varying from eight to sixteen inches, but on Dec. 21, an individual was taken at four inches or what is normally considered above the plow line (6 inches). On Dec. 23, another specimen was taken at six inches, and from that date on throughout the winter no individual was found below ten inches. In January and March specimens were taken at six inches, while in the sand dune area covered with dead grass one larva was found at five inches on March 23.

Wireworms were found in 25 of the 38 holes dug in 1925–1926. In each of two excavations ten individuals were taken; in the others generally only one but in a few cases two or three. Between Nov. 20, and Feb. 5, only one individual was found above the plow line while on Dec. 23, one larva was found at 6 inches. During this time the depths at which specimens were found ranged from eight to twenty-four inches with the majority between ten and fifteen inches. On Feb. 5, and frequently thereafter larvae were taken at shallow depths. However, on Feb. 27, one specimen was found in a sand dune area at 36 inches and on March 12 in river-bottom land one was collected at twenty-two inches. Two others were found on March 20 at 24 and 30 inches.

The collections of 1922–1923 and 1925–1926 are summarized and a comparison of the two seasons is shown in Table 1.

TABLE 1.—A SUMMARIZED COMPARISON OF THE 1922–1923 AND 1925–1926 HIBERNATION COLLECTIONS OF WIREWORMS

Date	Number collected	Depth collected Minimum	Maximum	Average
1922–1923	18	4 inches	16 inches	7.7 inches
1925–1926	74	3 inches	36 inches	10.1 inches

SUMMARY

Since little information is available concerning the winter habits of wireworms, the foregoing data is offered as a preliminary report on studies made in Kansas. Most of the observations were carried on in prairie sod land where wireworms would normally be considered abundant. The diggings failed to reveal many larvae in such situations. Most of the observations were made during two seasons and the average depth of those found during the two winters was 7.7 inches in 1922–1923 and 10.1 inches in 1925–1926. The fact of greatest interest, however, is that wireworms were frequently found above a depth of six inches, even in mid-winter, a location where they would have to endure much greater cold than individuals which penetrated the soil to greater depths. It is evident that these insects can endure wide extremes of temperature and that the oft recommended practice of fall plowing to expose them to the rigors of winter may have less value than is commonly attributed to the practice. It is also of interest, that an average number of 10 wireworms for each two by three foot excavation, as was found in two instances in 1925–1926, would represent a total population of 72,310 wireworms per acre.

THE EFFECT OF SUBMERGENCE DURING THE HIBERNATING PERIOD ON PUPAL FORMATION AND ADULT EMERGENCE IN THE EUROPEAN CORN BORER

By MILTON F. CROWELL

ABSTRACT

The writer attempted to discover the effect of prolonged submergence of the hibernating larvae of the European Corn Borer, *Pyrausta nubilalis* Hubn., upon the subsequent life history of individuals surviving such submergence. Seventy-eight per cent of larvae immersed for eleven days died before pupation. Pupation and adult emergence in larvae that survived such a period of immersion was apparently normal. This is the record of but one experiment, and the results may not indicate what would happen in nature.

The effect of dessication during the dormant period of the European Corn Borer, *Pyrausta nubilalis* Hubn., has received considerable study. K. W. Babcock, ('27) states that if dessication occurs during the dormant period retardation of pupation results, and ('24) that a dry month of March produces the greatest delay. The purpose of the writer's experiment was to initiate a study of the effect of the opposite environmental condition, namely excessive moisture, during the dormant period. Unfortunately, circumstances prevented the carrying out of the work as planned, and only one experiment was carried to a point where results could be recorded.

In a former paper ('26) the writer discussed the effect of submergence in water on the hibernating larvae, and pointed out that the hibernating larvae of this insect can survive a period of submergence from six to seven times as long as can the active larvae. No data were secured, however, on the effect of prolonged submergence on the subsequent life of those individuals that survived it.

The larvae used in this experiment were of the two generation strain found in New England. They were obtained in the stalks in which they had entered hibernation from the European Corn Borer Laboratory of the Bureau of Entomology, U. S. Department of Agriculture, at Arlington, Mass.

On March 25, 1926, fifty larvae were cut from corn stalks and were submerged in water. They were kept in an outdoor screened cage, subject to natural temperatures. On April 5, after a period of eleven days the larvae were removed from the water. They were allowed to stand until April 10, in the cage, and on that date each larva was placed in a small glass tube, the ends of which were plugged with absorbent cotton, which was moistened from time to time.

On April 6 fifty larvae were cut from corn stalks of the same lot and each was placed in a short glass tube similar to the tubes used for the submerged larvae. These larvae were set aside as checks. All were kept in the screened cage together so that all would be subjected to the same environmental conditions.

Of the fifty larvae that were immersed there is one of which I have no further record. Of the check larvae, there are six upon which I have no further data, and one escaped.

Of the larvae that had been immersed in water for eleven days 39, or 78 per cent, died before pupation. Of the checks, 19, or 38 per cent, died before pupation.

Ten larvae that had been immersed pupated. Twenty-four of the check larvae pupated. The dates of pupation follow:

Date	Immersed	Check
June 14	1	
15–18		6
19	1	
21–23		3
24	1	1
25–28		6
29	4	
30		4
July 1	1	
2–9		4
10–14	2	

Seven adults were obtained from the immersed indivuduals, and seventeen from the checks.

The dates of adult emergence are as follows:

Date	Immersed material		Checks	
	Males	Females	Males	Females
July 5	1			1
6–9			5	
10	1	1		
11–16			4	3
18	2			
19			2	1
20	2		1	

By comparing these dates it appears that the date of maximum pupation was July 4 for both sets of pupae, when there were 8, or 80 per cent, of the pupae of the immersed larvae and 22, or 91.66 per cent of the pupae of the checks.

The appearance of the first adult was the same for both sets of pupae.

The date of maximum pupation was the same.

The appearance of the first pupa was in the immersed material, one day earlier than that in the checks.

The pupal period of the immersed individuals averaged 19.57 days, and that of the checks averaged 18.5 days.

Of the seven adults from the immersed material, 6, or 85.71 per cent, were males, and one, or 14.29 per cent was a female. In the checks, 12, or 70.59 per cent, were males, and 5, or 29.41 per cent, were females.

Although the percentage of surviving males was much greater in the immersed material than in the checks in this material it may well be that in this individual experiment such chanced to happen, and that further observations would not confirm this.

SUMMARY

1. The mortality of larvae submerged for a period of eleven days during the latter part of the hibernating period is apparently much greater than that of larvae not so treated.
2. Submergence of larvae in the latter part of the hibernating period apparently does not have much effect on the time of pupation of these larvae, or upon the time of emergence of adults from the pupae of larvae so treated.
3. In this experiment the pupal period of the individuals subjected to submergence was one day longer than that of larvae not so treated. These averages are not from equal numbers of pupae, so it would be unsafe to draw a conclusion regarding this point from these data.
4. A greater percentage of females emerged from pupae, the larvae of which had not been subjected to submergence, than emerged from larvae that had been submerged.
5. This is the record of a single experiment, hence the conclusions which might be drawn from it may well be erroneous.

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SUMMARY OF THREE YEARS' TESTS OF TRAP BAITS FOR CAPTURING THE CODLING MOTH

By M. A. YOTHERS, *Associate Entomologist, Bureau of Entomology, United States Department of Agriculture, Yakima, Wash.*

It has long been known that many kinds of insects are readily attracted to certain kinds of baits. Little, however, has been recorded of the value of any of these in attracting the codling moth (*Carpocapsa pomonella* L.). It was with the view of determining the actual value of various attractive baits in capturing the moths that preliminary tests were begun at the Yakima, Washington, Station.

Tests made after late July, 1923, with vinegar, synthetic apple oil, and fermented apple juice, placed in glass jars set in the crotches of apple trees, showed little promise for this method of supplementary codling moth control.

No tests of baits were made in 1924, but in 1925 more comprehensive experiments were made than in 1923, and in 1926 a large number of tests were conducted throughout the season.

METHOD OF USING TRAP BAITS. In 1925 the bait containers were hung on a nail well up in the tops of the trees. In 1926 they were suspended by a hop cord run through a screw-eye inserted in a horizontal limb in the topmost part of the trees.

The baits were replenished when they needed it—sometimes certain kinds of baits had to be replenished about every 6 days, but others could go longer. During cool weather all baits required less replenishment on account of retarded evaporation. In the 1926 season baits were operated from April 17 to September 23 (160 days), and moths captured over a period of 148 days.

KINDS OF BAITS AND THEIR COMPARISON. In 1925 (Table 1) tests against the spring brood with vinegar, diluted with water, 50, 25, 10, and 5 per cent, and fermented apple juice, showed the apple ferment over 13 times as effective as the poorest vinegar (50 per cent) and about 3½ times as effective as the best vinegar (5 per cent). In the first brood, when cider, vinegar (5 per cent), and fermented apple juice were compared, cider proved over six times as attractive as vinegar, and apple ferment over eight times as attractive.

TABLE 1.—RELATIVE VALUE OF CODLING-MOTH TRAP BAITS, SPRING AND FIRST BROODS, YAKIMA, WASH., 1925

Spring brood		First brood	
Bait	Average number of moths caught per jar-day	Bait	Average number of moths caught per jar-day
Vinegar, 50 per cent...	0.15	Vinegar, 5 per cent....	0.13
Vinegar, 25 per cent...	.21	Cider................	.87
Vinegar, 10 per ent...	.58	Apple ferment........	1.08
Vinegar, 5 per cent....	.59		
Apple ferment.......	1.99		

In 1926 a very large number of experiments were conducted with a considerable number of different kinds of materials, among which were molasses ferment, honey ferment, apple ferment (cooked and raw), vinegar, buttermilk, corn-wheat ferment (with and without apple oil), molasses and water, and about two dozen different kinds of essential oils. Tests were also made as to the most effective height at which to hang the baits in the trees; and several types of containers were compared.

In most of these tests, for which 15 experimental plats in the orchard were used, the three most effective trap baits were, in the order of their

effectiveness, molasses ferment, apple ferment, and honey ferment (Tables 2, 3, 4, 5, 6, 7). The general superiority of the molasses-ferment bait over all others tested seems apparent.

TABLE 2.—RELATIVE VALUE OF CERTAIN CODLING-MOTH TRAP BAITS, PLAT B, SPRING BROOD, YAKIMA, WASH., APRIL 26 TO MAY 14, 1926

Bait	Average number of moths caught per jar-day
Molasses ferment	2.31
Honey ferment	.93
Apple ferment	.80
Vinegar, 10 per cent	.47
Citronella oil	.39
Clove oil	.26
Sassafras oil	.24

TABLE 3.—RELATIVE VALUE OF CERTAIN CODLING-MOTH TRAP BAITS, PLAT H, SPRING BROOD, YAKIMA, WASH., MAY 23 TO JULY 4, 1926

Bait	Average number of moths caught per jar-day
Molasses ferment with dry yeast	1.04
Molasses ferment with fresh yeast	.93
Apple ferment	.33

TABLE 4.—RELATIVE VALUE OF CERTAIN CODLING-MOTH TRAP BAITS, PLAT G, SPRING BROOD, YAKIMA, WASH., MAY 17 TO 29, 1926

Bait	Average number of moths caught per jar-day
Molasses ferment	0.91
Apple ferment	.39
Honey ferment	.25
Vinegar, 10 per cent	.20

TABLE 5.—RELATIVE VALUE OF CERTAIN CODLING-MOTH TRAP BAITS, PLAT I, SPRING BROOD, YAKIMA, WASH., MAY 29 TO JULY 4, 1926

Bait	Average number of moths caught per jar-day
Molasses ferment	1.03
Corn-wheat ferment	.63
Corn-wheat ferment and apple oil	.50

TABLE 6.—RELATIVE VALUE OF CERTAIN CODLING-MOTH TRAP BAITS, COMPARABLE PARTS OF PLATS B, G, AND J, SPRING BROOD, YAKIMA, WASH., APRIL 29 TO JULY 4, 1926

Bait	Average number of moths caught per jar-day
Molasses ferment	1.04
Honey ferment	.57
Apple ferment	.44
Vinegar, 10 per cent	.16

TABLE 7.—RELATIVE VALUE OF CERTAIN CODLING-MOTH TRAP BAITS, PLAT A, FIRST BROOD, YAKIMA, WASH., JULY 10 TO SEPTEMBER 17, 1926

Bait	Containers	Average number of moths caught per jar-day
Molasses ferment	pans	3.28
Apple ferment, cooked	pans	2.76
Apple ferment, raw	pans	1.82
Apple ferment, cooked	jars	1.60
Apple ferment, cooked	pails	1.45
Molasses ferment	jars	1.45
Apple ferment, cooked, diluted 50/50	pans	1.27
Honey ferment	pans	1.09
Honey ferment	jars	1.06
Apple ferment, cooked, diluted 1 to 2	jars	.66
Apple ferment, raw	jars	.65
Apple ferment, cooked, diluted 50/50	pails	.60
Apple ferment, raw	pails	.54
Vinegar, 10 per cent	jars	.21

Of the essential oils tested only three, oil of cloves, oil of citronella, and oil of sassafras, showed any attractive value, and these captured few moths compared with the ferments (Table 2).

KINDS OF CONTAINERS. In the comparison of kinds of containers it was shown that 1½-gallon pails caught many more moths than "milk-kettles" or cuspidors (Table 8), but that enameled kettles or pans, 3 inches deep and 8 inches in diameter, were much more effective than the 1½-gallon pails or the quart fruit jars (Table 9).

TABLE 8.—RELATIVE VALUE OF VARIOUS KINDS OF CONTAINERS FOR CODLING-MOTH TRAP BAITS, PLAT D, SPRING BROOD, YAKIMA, WASH., APRIL 29 TO JULY 4, 1926

Containers with apple ferment	Average number of moths caught per jar-day
Pails, 1½-gallon, tin	1.01
"Milk-kettles," ½-gallon, tin	.62
Cuspidors, 1-quart, tin	.33

TABLE 9.—RELATIVE VALUE OF VARIOUS KINDS OF CONTAINERS FOR CODLING-MOTH TRAP BAITS, PLAT A, FIRST BROOD, YAKIMA, WASHINGTON, JULY 10 TO SEPTEMBER 17, 1926

Containers	Average Number of moths caught per jar-day in—			
	Molasses ferment	Apple ferment, cooked	Apple ferment, raw	Honey ferment
Pans or kettles, enameled	3.28	2.76	1.82	1.09
Jars, glass	1.45	1.60	.65	1.06
Pails, tin	—	1.45	.54	—

TABLE 10.—HEIGHT OF CODLING-MOTH TRAP BAITS IN TREES AS AFFECTING THEIR EFFICIENCY, PLAT B, FIRST BROOD, YAKIMA, WASH., JULY 22 TO SEPTEMBER 20, 1926

Bait	Position	Average number of moths caught per jar-day
Apple ferment	High	2.79
Apple ferment	Low	.65

HEIGHT OF BAITS IN TREES. In the comparison of height of baits in the trees (Table 10), it was found that baits hung well up in the tops of trees caught 4.29 times as many moths as did a like number of jars hung only about 5 feet from the ground.

PROPORTION OF SEXES. The proportion of the sexes, as shown in Table 11 for the three years during which these tests were conducted, indicates that somewhat more than half of the moths caught are females. Apparently about 55 to 60 per cent of the moths captured are females.

TABLE 11.—RELATIVE PROPORTION OF SEXES OF CODLING MOTHS CAPTURED IN BAITED TRAPS, YAKIMA, WASH., 1926

Year	Number of—		Per cent females
	Females	Males	
1923	93	68	57.76
1925	1,910	1,217	61.08
1926	8,575	6,585	56.56
Total	10,578	7,870	
Average			57.34

FEMALE MOTHS CAPTURED BEFORE DEPOSITING EGGS. A number of examinations of female moths during the season of 1926 showed about 95 per cent of them gravid or largely so. A very small number contained only a few eggs, and rarely one contained none. These semigravid or spent females had evidently not found the baits until after they had deposited their eggs; or those with no eggs may have been sterile. In other words it would seem that nearly all of the moths are captured in the baits soon after emergence and before they lay many of their eggs.

EFFECT OF TEMPERATURE UPON CAPTURE OF MOTHS. There is a very definite relation between temperature and the flight activity of the codling moth. This relation has been pointed out by other workers in connection with the deposition of eggs, but it is equally apparent in relation to the flight activity of the moths as indicated by the number captured in the baits. A few moths were captured even when it was running generally cool (around a mean daily temperature of 55 to 60°F.), but most of them are attracted when the mean daily temperature

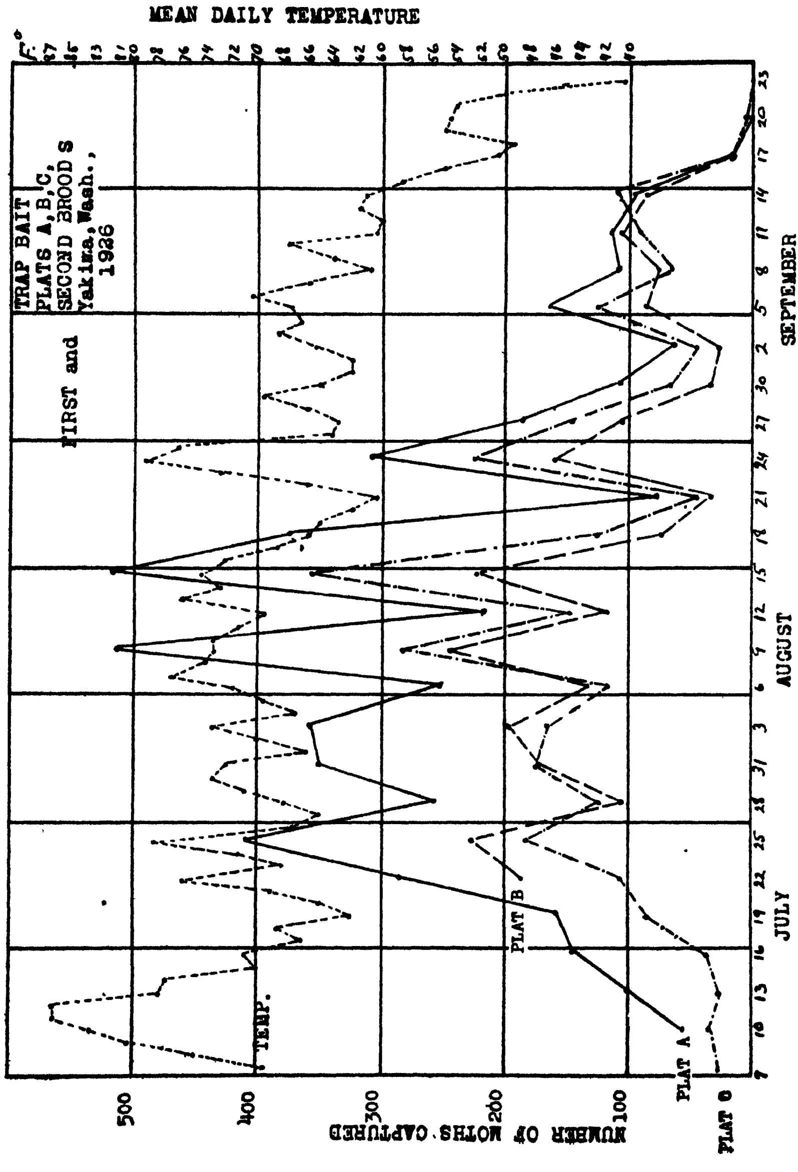

FIG. 19.—The effect of temperature upon the flight activity of the codling moth as indicated by the number of moths captured in trap baits in three experimental plats during the first and second broods, Yakima, Wash., 1926.

is above 70°F. A sudden drop in temperature will practically stop all moths from visiting the trap baits until it has warmed up again. In Figure 19 is shown graphically the regular rise and fall in the number of moths captured in three different plats during the flight of the first brood, as related to the temperatures of the three days immediately preceding each examination. The mean temperature for each day is given.

Control Value of Trap Baits. Although it has long been known that certain kinds of baits would attract the moths, it has never been definitely recorded, as far as we have been able to learn, just what is gained in actual control. The question naturally arose, Does capture of a few thousand moths materially affect the total number present in an orchard? In order to gain some information on this point a thorough test was made the past season as follows: A block of 42 apple trees was baited with apple ferment, a quart fruit jar to each tree, from April 20 to September 23. At harvest time the crop on 12 trees in this block and 12 trees outside this block was counted and examined for the percentage of fruit free from worms and stings. In the baited block 6 Jonathan trees averaged 92.06 per cent free from all worms and stings (Table 12); a like number of Jonathans in the unbaited block averaged 79.93 per cent free from worms and stings. Six Rome Beauty trees in the baited block averaged 90.36 per cent fruit free from worms and stings, and a like number of the same variety in the unbaited block averaged 74.77 per cent of the fruit free from worms and stings. In other words, the baits in the Jonathans showed an increase of clean fruit of 12.13 per cent, and the Rome Beauties an increase of 15.59 per cent. Both blocks had received the same spraying by the owner. Certainly a control measure that increases the proportion of clean fruit 16 per cent (from 74 to 90 per cent) or 12 per cent (from 80 to 92 per cent) is worthy of consideration as at least promising provided such a measure is within the bounds of reasonable expense.

Table 12.—Control Value Against the Codling Moth of Apple Ferment Bait in a Block of 42 Trees, with Bait Jars in Each Tree From April 20 to September 23, Yakima, Washington, 1926

Plat	Variety	Treatment	Per cent of fruit free from worms and stings	Per cent of increased control
I	Jonathan	Baited	92.06	12.13
II	Jonathan	Unbaited	79.93	——
I	Rome Beauty	Baited	90.36	15.59
II	Rome Beauty	Unbaited	74.77	——

Cost of Trap Baits. The figures on the cost of operating trap baits are largely a matter of estimate and theoretical computation. However, after very careful consideration, the following estimates have been made. Estimates for the molasses ferment and the apple ferment only are given as all other baits tested seem to fall far behind these in value, except the honey ferment, which is too expensive to be seriously considered. The estimated cost is given per tree per season of 20 weeks from late April to late September.

Molasses ferment bait	Cost per tree per season
Molasses	$0.1500
Yeast	0.0125
Screw-eye	0.0050
String	0.0200
Pan	0.1500
Labor	0.2400
Total	$0.5775 (or 58 cents)

This expense could very probably be greatly reduced as follows: (1) By purchasing cheap molasses in large quantities, provided that this should prove as attractive as the better grades; (2) by diluting the molasses 1 to 20 instead of 1 to 10 as at present, provided this should prove as effective; (3) by hiring cheap labor (boys could do this kind of work as well as higher priced labor); (4) by eliminating two or more of the late September examinations, when few moths would be captured at best; (5) by using the pans for three or more years instead of one, thus reducing the cost of containers by cutting it into thirds. With all of these reductions the annual cost per tree would probably not greatly exceed one-half the estimated amount.

The cost of the apple-ferment bait is about the same as the cost of the molasses ferment except in the matter of the apple juice alone, which is mainly the cost of labor in grinding and cooking the apples. It is estimated that this could be done in large quantities for about 1 cent per tree per season, but for smaller lots, for 5 acres or less, the cost would probably run around 4 to 5 cents. In other words, the apple ferment bait, while apparently not so efficient as the molasses ferment, would probably cost about 45 to 50 cents per tree per season compared with 55 to 58 cents for the molasses ferment.

Summary and Conclusions

In badly infested apple orchards thousands of codling moths to an acre can be captured in properly baited traps during the moth season.

Cooked, fermented apple juice, containing some of the apple pulp,

proved more attractive in capturing the moths than vinegar or cider.

In 1926 a molasses ferment proved much more effective than apple ferment, honey ferment, or any of some two dozen essential oils.

Of the essential oils only three, oil of cloves, oil of citronella, and oil of sassafras, proved attractive to the codling moths.

The most promising type of bait container so far found is an enameled kettle about 8 inches in diameter and 3 inches deep.

Several times as many moths can be captured in baits in the tops of trees as in baits at the height of the crotches.

About 55 or 60 per cent of the moths captured are females.

Of the moths caught about 95 per cent are gravid, having laid none or very few of their eggs before capture.

Trap baits show the beginning and end of the codling moth season, the beginning and end of each brood, and the maximum abundance for each, and this information may be used to advantage in arranging spray dates for moth control.

Codling moths are not attracted to baits during cool weather. Most of them are captured while the mean temperature is 70°F. or above.

In a baited test block of 42 trees, final counts of fruit at harvest time showed an increase of from 12 to 16 per cent over similar varieties similarly sprayed but unbaited.

The cost of molasses ferment, which proved the most efficient, is estimated at not over 58 cents per tree per season, and for the apple ferment about 45 to 50 cents on the same basis.

Apparently there is a possibility that some attractive bait may be discovered which will attract and capture the codling moth in such numbers that it may be recommended as a satisfactory supplementary control measure.

CALCIUM CYANIDE FOR THE CONTROL OF THE SQUASH BUG, *ANASA TRISTIS* DE GEER

By V. A. Little, *College Station, Texas*

Abstract

During the summer of 1926 experiments were conducted upon squashes with cyanogas calcium cyanide "A" dust for the control of squash bugs. Over 80% control was obtained with undiluted dust. All dusting was done in the open air. Applications were very heavy, using 1½ ounces of dust per hill. Little or no injury was noted when the dust was properly applied.

An effort was first made to control squash bugs with nicotine dust. Dusts containing 2% and 4% nicotine were used; both proved inefficient.

Cyanogas calcium cyanide "A" dust was next employed. In addition to the experiments with the undiluted "A" dust other experiments were conducted with a dust made by mixing it with various proportions of air slaked lime in an effort to obtain a cheaper product and one with better dusting qualities. Preliminary experiments showed that the undiluted dust and a mixture of one part "A" dust with one-half part air slaked lime were worthy of further trial. All dusting was done in the open air; the dust was delivered with a hand duster. The applications were thoroughly made; about 1½ ounces was used upon each hill.

All tests were made upon plats containing from seven to twelve hills each. Counts were made from one hill in each plat. The stupefied bugs from each hill upon which counts were made were spread upon the ground in wire cages, 1′ x 1′ x 2′ in the field. Checks were run by placing an equivalent number of nymphs and adults in similar cages under the same conditions and kept there until all the stupefied bugs from the dusted plats had either died or recovered. Fresh leaves with stems attached were placed in the cages twice daily. Table 1 shows the results obtained.

TABLE 1

Plat No.		Nymphs		Adults		Total
		Total	% Died	Total	% Died	% Died
1	Calcium cyanide undiluted	307	89.2	7	42.9	88.2
2	Calcium cyanide and lime	1138	83.9	2	50.0	83.8
Check 1 and 2		304	8.2	18	0	7.8
3	Calcium cyanide undiluted	262	84.7	22	77.3	84.2
4	Calcium cyanide and lime	103	55.3	12	25.0	52.2
Check 3 and 4		200	0.5	9	0	0.5

Upon examination of this table it is seen that fair control was obtained with the straight "A" dust. The reason for the high mortality in the check for plats 1 and 2 seems to be that at this time the major per cent of the nymphs were newly hatched. A comparison of the total number in 3 and 4 shows a material decrease in the latter.

When the plats were dusted the bugs were quickly stupefied; the time varying from twenty seconds to one minute, depending upon the dosage and the wind velocity. All that were stupefied were by no means dead. A few recovered within a few minutes. All adults that did recover did so within twenty-four hours. Some showed signs of life after forty-eight hours but none recovered. Very few nymphs recovered after twenty-four hours and none after forty-eight hours, however, a few still showed

signs of life after seventy-two hours. Table 2 shows the per cent of bugs that recovered.

TABLE 2

Plat No.	Nymphs		Adults		Total
	No. Stupefied	% Recovered	No. Stupefied	% Recovered	% Recovered
1	304	9.9	7	57.1	10.9
2	1084	11.8	2	50.0	11.9
3	262	15.3	22	22.7	15.8
4	101	5.5	12	75.0	48.7

Checks as for Table No. 1.

Burning resulted only when the dust was applied very heavily directly upon the leaves. Ordinarily there is no need of applying the dust directly upon the leaves as the bugs are found upon the stems near the base of the plants. The insects are found in numbers on the leaves only when the nymphs are small; in this case they are brushed to the ground and then dusted, thus eliminating the possible danger of burning and getting them where the dust will be more effective. Table 3 shows the weather conditions at the time of dusting.

TABLE 3

Plat No.	Date	Time	Estimated wind velocity	Temperature	Humidity
1	July 17	3:00 P. M.	4 Mi.	88	58
2	July 17	4:30 P. M.	5 Mi.	87	55
3	July 23	9:30 A. M.	3–4 Mi.	80	92
4	July 23	10:00 A. M.	3–4 Mi.	80	88

LEAF-HOPPERS INJURIOUS TO APPLE TREES IN THE HUDSON VALLEY

By F. H. LATHROP[1]

ABSTRACT

A leaf-hopper (*Typhlocyba pomaria* McAtee) closely resembling the rose leaf-hopper (*T. rosae* Linn.) was observed causing serious injury to apple trees in the Hudson Valley. The injury takes the form of white stippling of the foliage, resulting in serious loss of chlorophyl in severe cases. More or less discoloration of the fruit results from the honey dew discharged by the insects. Severe infestation was observed on McIntosh, Baldwin, and Greening apple trees, ranging from McIntosh of early bearing age to mature Baldwins.

The adults of *T. pomaria* and *T. rosae* are distinguished by the structure of the genitalia; the nymphs of the former species lack the dark spots characteristic of *T. rosae*.

[1]The writer is indebted to Professor P. J. Parrott for encouragement in carrying on this work, and to Mr. W. L. McAtee for assistance in examinations of the male genitalia of the species involved.

The winter eggs of *T. pomaria* are found in apple bark, mostly on second year wood. In 1924 hatching began on May 19, two weeks later than the hatching of the first eggs of *T. rosae*. The first adults appeared during the third week in June. The first eggs of the second generation were observed on July 23. Hatching began during the second week in August, and adults appeared in mid-September. The winter eggs are deposited during late fall.

The most effective control of *T. pomaria* was secured by an application of nicotine sulphate (3/4 pint to 100 gallons), applied after all of the winter eggs had hatched but before any adults appeared. Two per cent nicotine-lime dust was effective during mid-July when the adult hoppers predominated. Oil sprays, applied at the delayed dormant period, proved ineffective in destroying the winter eggs.

During the seasons of 1923 and 1924, while employed by the New York Agricultural Experiment Station, the writer had opportunity to make observations on leaf-hoppers infesting apple orchards in the fruit sections of the Hudson Valley. A number of orchards were observed, in which the owners reported that severe leaf-hopper infestation had persisted for several years.

At first it was believed that this was the rose leaf-hopper, *Typhlocyba rosae*. As the work progressed, it soon became evident that there were two species involved: the rose leaf-hopper, *Typhlocyba rosae* Linn., occurring on apple during the summer months, and wintering on rose; and another species, which spends its entire life cycle upon apple. The latter species has been described by McAtee in his recent monograph on the genus Typhlocyba, in which he gives it the name *Typhlocyba pomaria*.[2]

Distinguishing Characteristics. The eggs of *T. pomaria* so closely resemble those of the rose leaf-hopper, that no means was found for distinguishing them. The winter eggs of the rose leaf-hopper were observed to be placed under the bark, usually parallel to the axis of the stem, while the eggs of *T. pomaria* are characteristically placed at right angles to the axis of the stem. The writer cannot say that this is invariably the case, however.

The Nymph of *T. pomaria* may be distinguished by the absence of the dark spots at the bases of the thoracic bristles, which are characteristic of the rose leaf-hopper.

The Adult very closely resembles the rose leaf-hopper in color and in general shape and size The males of the two species may be distinguished by the structure of the aedeagus. The ultimate ventral segment of the female is distinctive, but in many cases this becomes

[2]McAtee, W. L., *in* Proc. U. S. Nat'l. Museum, Vol. 68, Art. 18, pp. 1–47, pls. 1–6, 1926.

distorted in dried, mounted specimens. There are also differences in the wing venation, that seem quite constant.

ECONOMIC IMPORTANCE. In a number of apple orchards in the Hudson Valley, severe injury has been noticed, and the writer has observed one orchard where the infestation has persisted for at least four years. The injury produced is apparently identical with that caused by the rose leaf-hopper. The leaves show white stippling on the upper surface along the veins as the nymphs begin to feed. As infestation becomes more severe, the white spots become more abundant, until the whole leaf becomes pale in color, and in extreme cases the tree may lose a large proportion of its chlorophyl. In addition to this foliage injury, there is more or less trouble from the discoloration of fruit by excreta, which is quite characteristic of leaf-hopper attacks. Some fruit growers believe that severe attacks of this leaf-hopper resulted in a reduction in the size of the fruit, and in failure of the fruit to color properly.

Severe infestations were observed on McIntosh, Baldwins, and Greenings, and there are probably other varieties that suffer equal

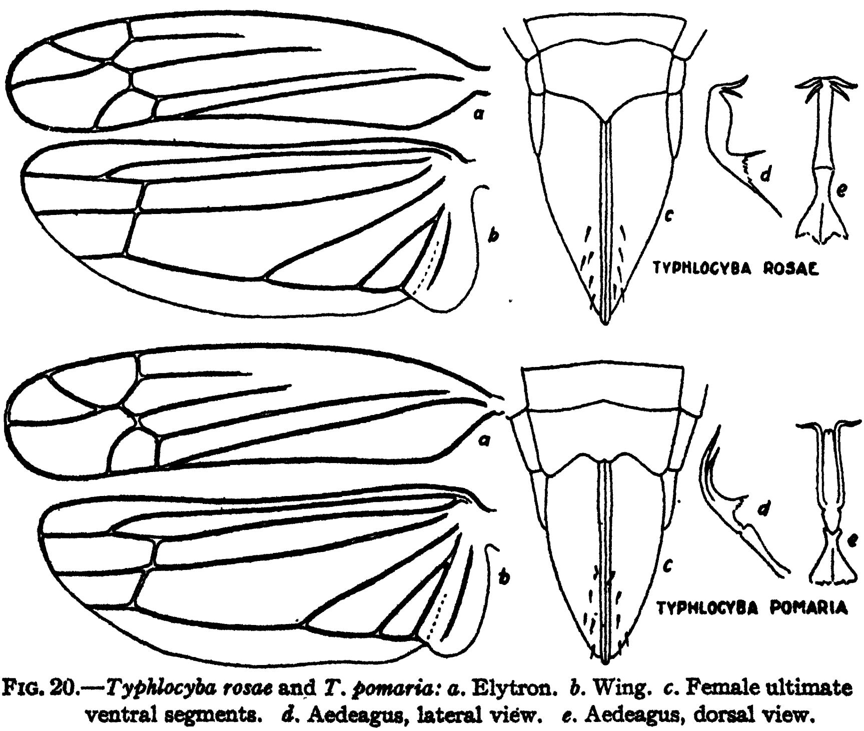

FIG. 20.—*Typhlocyba rosae* and *T. pomaria*: *a*. Elytron. *b*. Wing. *c*. Female ultimate ventral segments. *d*. Aedeagus, lateral view. *e*. Aedeagus, dorsal view.

injury. The trees affected ranged in age from McIntosh of early bearing age to mature Baldwins. No infestation was observed on very young trees.

Distribution. Infested orchards were observed at Marlborough, Milton, Clintondale, and Highland, New York. In all of these orchards *T. pomaria* far outnumbered *T. rosae*. In no case was a severe infestation of *T. rosae* observed in an apple orchard in the Hudson Valley; no thorough survey was made, however. An examination of the experiment station orchards at Geneva, N. Y., in 1924 showed infestation by *T. rosae*, but no specimens of *T. pomaria* were found.

In view of the fact that McAtee reports *T. pomaria* widely distributed throughout the United States and Canada, it seems likely that severe infestations of this species occur in apple orchards here and there as local environmental factors and climatic conditions favor the development of the species. This spotted nature of infestation seems characteristic of a number of leaf-hopper species.

Life History. The overwintering eggs of *T. pomaria* are deposited in apple bark, mostly on second year growth. In 1924 the first eggs hatched on May 19, which was two weeks later than the hatching of the first eggs of the rose leaf-hopper.

The first adults appeared during the third week in June. The metamorphosis proceeded rapidly, and, by the end of June, practically all of the nymphs had transformed into adults.

The first eggs of this generation were observed on July 23, when one egg was found imbedded in a leaf petiole. Three days later eggs had become numerous, and as many as fourteen eggs were found in the petiole, midrib, and larger veins of a single leaf.

The first nymphs of the second generation appeared during the second week in August. Infestation rapidly grew more severe, and with adults of the first generation and all stages of nymphs of the second generation present on the foliage, the injury became excessive.

Adults of the second generation appeared on the apple foliage in mid-September. From this time on, the relative numbers of adults increased, until mid-October, when most of the hoppers were in the adult or late nymphal stages.

During late afternoons in November or on dull, cloudy days, numbers of adults may be observed depositing the over-wintering eggs in the apple bark. Adults may be found in decreasing numbers until frost removes the foliage from the trees.

Control. The most effective control of *T. pomaria* in apple orchards

of the Hudson Valley was secured by a well timed application of nicotine sulphate (¾ pint to 100 gallons), applied so as to kill the nymphs. This application should be made during late May or early June after all of the overwintering eggs have hatched, but before any of the adults have appeared. The nicotine sulphate may be added to one of the customary applications scheduled to be made during this period, thereby eliminating the necessity for an additional spray application. It is advantageous to make the application promptly after all of the eggs have hatched, for the early stages of the nymphs are more susceptible to the spray than are the nearly mature nymphs.

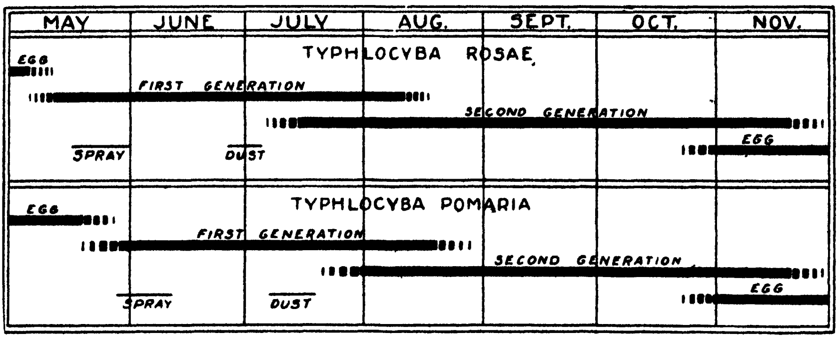

FIG. 21.—Graph showing life history of two apple leaf hoppers.

There is a period during mid-July when practically all of the first generation hoppers have transformed to adults, yet few, if any, eggs have been deposited. This period is most advantageous for dust applications. Experimental applications of 2 per cent nicotine-lime dust proved effective against the adults when weather conditions were satisfactory.

Oil sprays, applied at the delayed dormant period, in an effort to destroy the overwintering eggs, proved ineffective, and resulted in no material reduction of leaf-hopper infestation.

NOTES ON COLLECTIONS OF THE SUGAR BEET LEAF-HOPPER SHOWING THE EXTENSION OF ITS KNOWN RANGE INTO BRITISH COLUMBIA AND TO THE COAST IN WASHINGTON AND OREGON

By EDGAR W. DAVIS, *Junior Entomologist, Bureau of Entomology*

ABSTRACT

The known range and breeding areas of the sugar beet leaf-hopper (*Eutettix tenella* Baker) are important in locating new areas for the production of sugar beets.

The results of the survey recorded in this paper extend the known range of the leafhopper to the coast in Washington and Oregon and into British Columbia, 140 miles north of the international boundary. Observations on the stage of the insect, host plant, date and locality are recorded.

Introduction

Information regarding the known range of the sugar beet leaf-hopper (*Eutettix tenella* Baker) and the locations of breeding areas is of importance when new areas for sugar beet production are under consideration. Such information increases in importance when severe losses occasioned by repeated leaf-hopper outbreaks in the areas now devoted to sugar beet growing lead the sugar beet industry to seek new fields for production. With this in view, a survey was made during the past season on the west coast of Washington and Oregon and up into British Columbia.

Ball[1] reported that *E. tenella* was swarming on Atriplex at Pendleton, Oreg., and Yakima, Wash., in 1909. Also, that this leaf-hopper was common as far north as Wenatchee, Washington. In 1904 Titus[1] reported serious injury in beet fields at Echo, Oreg.

Carter[2] notes the presence of the insect as far west as The Dalles and south in Oregon to Prineville; also, as far north as Okanogan, Wash.

The records of collections of *E. tenella* made during 1926 in British Columbia and on the west coast of Washington and Oregon follow.

Wenatchee Valley, August 10

This part of the survey duplicates the work done last year[2] and confirms the data then obtained. Adults and nymphs of *E. tenella* were found throughout the valley. The host plants were Russian thistle (*Salsola pestifer* A. Nels.) and Jim Hill mustard (*Norta altissima*(L.) Britton). The latter was dead and the leaf-hopper was not collected from it.

Okanogan Valley, August 12

This valley extends from Okanogan, Wash., to Chase, B. C. The south end of the valley, the widest part, was covered with grass and sage brush. Toward the north the valley narrows until it is lost in the forest-covered hills. Adults and nymphs of *E. tenella* were collected from Russian thistle and mangels. Other host plants found in this valley were Jim Hill mustard, *Atriplex rosea* L., and filaree (*Erodium cicutarium* (L.) L'Her).

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[1]E. D. Ball, Utah Agric. Col. Exp. Sta. Bul. 155.

[2]Walter Carter, Manuscript notes.

THOMPSON VALLEY, August 14

The Thompson valley was entered at Chase, B. C., and followed through Kamloops and Ashcroft to Spencer's Bridge, B. C. This valley was narrow and winding. At Chase the forest extended to the edge of the valley, while farther down the lower hills were covered with grass and sage brush. Both adults and nymphs were collected from Russian thistle at Chase and Merritt. Near Ashcroft the leaf-hopper became very scarce and only adults were collected. The mustard was greener in this valley than any which had been noted earlier in this survey, but no *E. tenella* could be found on it. *Atriplex rosea* and *Erodium cicutarium* were also found in this valley.

VALLEY OF BONAPARTE RIVER FROM ASHCROFT TO CANIM LAKE, August 17

From Ashcroft the survey turned north and followed the Bonaparte River to Clinton. *E. tenella* was found only at Cache Creek which is 8 miles north of Ashcroft. Mangels, *Atriplex rosea, Erodium cicutarium,* and Russian thistle were present in this area.

From Clinton to Canim Lake the valleys lie at right angles to the road. All the hills were covered with forests, consequently collections were made only in the valleys. No sugar beet leaf-hoppers were collected in this area, although the following host plants were found: *Atriplex rosea, Erodium cicutarium,* mangles, and Swiss chard (*Beta vulgaris*).

At Cache Creek, B. C., the northern limit at which *E. tenella* was found, only adults were taken. These might have migrated from the south. At Merritt the leaf-hopper was breeding, as both adults and nymphs were found. *Erodium cicutarium*, which is an early spring plant, grows rank during the summer in this area and remains green until late fall. Other summer host plants have been noted. This section could be a natural breeding area, as far as host plants are concerned.

WESTERN WASHINGTON, August 30

From the Canadian border to Olympia, Wash., the farming region lies but little above sea level. This district is divided naturally into small farming areas by low forest-covered hills. The host plants of the leaf-hopper in this region were beets, mangels, *N. altissima, E. cicutarium,* and *A. rosea*. At Bellingham, Mt. Vernon, and Kent the leaf-hopper was found on beets. The other host plants were uninfested.

From Olympia to Vancouver, Wash., the course of the survey was between the Cascade Mountains and the Coast Range. The general

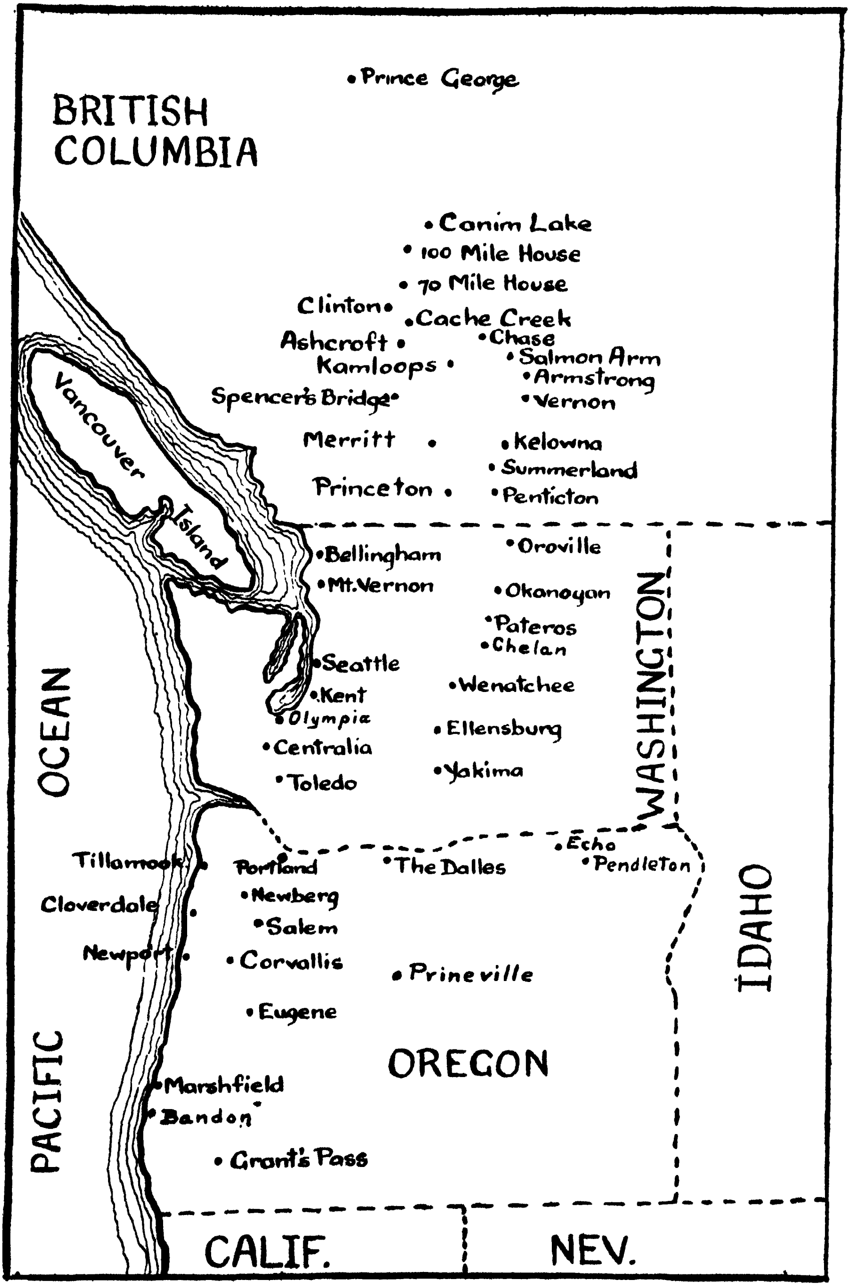

FIG. 22.—Area in the Pacific Northwest covered by the sugar beet leaf-hopper survey made in 1926.

elevation of the farming area here was higher than that previously described. This region is divided into small valleys enclosed by forest-covered mountains. In addition to the host plants previously mentioned, the following were found: *Sanguisorba annua* Nutt. and *Anthemis cotula* L. At Centralia and Toledo the leaf-hopper was found on mangels.

Western Oregon, September 7–15, 1926

The major part of the survey in western Oregon was made between the Cascade Mountains and the Coast Range, from Portland to Grant's Pass. This region is divided into valleys of various sizes, each surrounded by forest-covered mountains. The type of farming varies from grain to truck farming and dairying. Mangels were plentiful throughout this region. Other host plants found there were beets, *Erodium cicutarium*, *Atriplex rosea*, and *Sanguisorba annua*. The only place that *E. tenella* was found was at Newberg, on mangels.

The minor part of the survey was made along the coast between Tillamook and Newport, and in the region between Marshfield and Bandon. Dairying was the main type of farming; consequently, mangels were plentiful. At Cloverdale adults and nymphs were collected from mangels. Other host plants found on this part of the survey were *Atriplex rosea* and *Erodium cicutarium*. The latter plant grows in this section the entire year. Summer plants appear early in the spring and remain late in the fall. These conditions indicate that this section could be a natural breeding area.

Summary

Nymphs and adults of the sugar beet leaf-hopper (*Eutettix tenella* Baker) were found throughout the Wenatchee and Okanogan Valleys and as far north as Merritt, B. C.

The northern limit at which the insect was found was Cache Creek, B. C.

Adults were found west of the Cascade Mountains in Washington and Oregon, and both adults and nymphs were found west of the Coast Range at Cloverdale, Oreg.

Throughout this entire survey, where the insect was found on beets or mangels, the curly-top disease was present.

This survey extends the known range of the sugar beet leaf-hopper to the coast in Washington and Oregon, and into British Columbia 140 miles north of the international boundary.

The accompanying table and map show the location and host plants of collections made during this survey.

COLLECTIONS OF THE SUGAR BEET LEAF-HOPPER MADE IN A SURVEY IN OREGON, WASHINGTON, AND BRITISH COLUMBIA IN 1926

Area	Locality	Host	Stage collected
Wenatchee Valley	Wenatchee, Wash.	Russian thistle	Adults and nymphs
	Chelan, Wash.	do	Adults
	Pateros, Wash.	do	Adults and nymphs
Okanogan Valley	Okanogan, Wash.	do	do
	Oroville, Wash.	do	Adults
	Osoyoos, B. C.	do	Adults and nymphs
	Summerland, B. C.	Mangels	do
	Kelowna, B. C.	do	Adults
	Vernon, B. C.	Russian thistle	do
	Armstrong, B. C.	Mangels	do
	Salmon Arm, B. C.	do	do
Thomson Valley	Chase, B. C.	Russian thistle	Adults and nymphs
	Kamloops, B. C.	do	Adults
	Ashcroft, B. C.	do	do
	Merritt, B. C.	do	Adults and nymphs
Valley of Bonaparte River	Cache Creek, B. C.	do	Adults
Western Washington	Bellingham	Beets	Adults
	Mt. Vernon	do	do
	Kent	do	do
	Centralia	Mangels	do
	Toledo	do	do
Western Oregon	Newberg	do	do
	Cloverdale	do	Adults and nymphs
	The Dalles	Russian thistle	do

CURLY-TOP OF SUGAR BEETS IN SOUTH DAKOTA

By HENRY H. P. SEVERIN, Ph.D., *California Agricultural Experiment Station*
and HARRY C. SEVERIN, M.A., *South Dakota State College*

ABSTRACT

Curly-top of sugar beets was found to occur, on rare occasions, in the beet fields of the west central part of South Dakota. Sweepings with an insect-net from the most favorable host plants of the beet leafhopper (*Eutettix tenella* Baker) failed to include a single beet leafhopper. It was demonstrated, however, that non-infective beet leafhoppers transmitted curly-top from South Dakota diseased beets to healthy beet seedlings under greenhouse conditions in California.

Curly-top of sugar beets was found in the beet fields in the territory of the Great Western Sugar Company in the west central part of South Dakota during the summer of 1926. An examination of one of the beet fields of the Great Western Sugar Company Farm, situated about one mile east of Belle Fourche, showed the presence of three curly-top beets in about 100 feet of beet row. A general survey was then made

of 3000 acres of beets in South Dakota and in many fields not a single diseased beet could be found. A typical case of curly-top in an advance stage of the disease with wart-like protuberances on the lower surface of the leaves was found on the Federal Experiment Farm near Belle Fourche. A badly stunted diseased beet was removed from a field near a beet dump at Nisland. After the general survey was made, it was decided to spend another day in the beet fields of the Great Western Sugar Company Farm totaling about 1100 acres. A general survey of the beet farm showed that curly-top was scarce, for not more than one diseased beet could be found in a half hour's search.

Beets showing the early symptoms of curly-top, namely the transparent veinlets on the inner or youngest leaves, or the advanced stage of the disease already described were sent from South Dakota to the greenhouse at the University of California. Non-infective beet leafhoppers transmitted curly-top from six of these beets to healthy beet seedlings. Repeated tests of non-infective beet leafhoppers failed to transmit the disease from one beet with a white venation and outward curled and crinkled leaves to healthy beets.

In our survey, a cross section of the northern and central parts of South Dakota was made, and in this survey over 1500 miles were covered in an automobile from August 9 to 18, 1926. The most favorable host plants of the beet leafhopper were swept with an insect-net but not a single specimen of *Eutettix tenella* Baker was captured. Russian thistle (*Salsola kali tenuifolia*), one of the most favorable introduced host plants of the leafhopper was most abundant in South Dakota. Another favorable introduced host plant was Red Orache (*Atriplex rosea*). Among the favorable native annual saltbushes was Fog Weed (*A. argentea*), Spear Orache (*A. patula hastata*) and Ribscale (*A. powelli*). Moundscale (*A. nuttalli*) a perennial saltbush, occurred in the northwestern part of the State. Several species of Pigweeds (*Chenopodia*) were also swept with an insect-net. Tumbling Mustard (*Sisymbrium altissimum*), one of the most important host plants of the beet leafhopper in Idaho, on the authority of Mr. Walter Carter, was also found in northwestern South Dakota.

Much of the Black Hills are forested, while the foothills are covered in part with tall grass, conditions which do not produce favorable natural breeding areas of the beet leafhopper.

No beet leafhoppers were taken on favorable host plants in the south central and southeastern parts of the State by the junior writer in a second trip covering 800 miles from September 1 to September 12, 1926.

No beet leafhoppers were found among the undertermined Jassids

collected in South Dakota during the past two years by the junior author, nor in the large collection of determined Jassids collected by the same individual during the past 15 years.

West central and northwestern South Dakota may be the eastern limit of a natural breeding ground of *Eutettix tenella*, providing the few cases of curly-top which we found were caused by this insect. Semi-arid conditions, some alkali soil with an occasional alkali sink covered with favorable host plants of the beet leafhopper were found in this locality. In the extreme northwestern part of the State, the average rainfall is less than 15 inches, in the Belle Fourche district 14 inches, an amount which at least some of the leafhoppers survive in the natural breeding areas of California. If *Eutettix tenella* is responsible for the diseased beets which we found in South Dakota, there is a possibility that the insect migrated into west central South Dakota from more remote breeding sections. Investigations should be conducted over a period of several years to determine whether west central and northwestern South Dakota is the boundary of a natural breeding area and whether or not a dispersal of leafhoppers takes place from this section or whether a migration in South Dakota takes place from regions outside of the State.

ACKNOWLEDGMENT

The survey of South Dakota for the beet leafhopper and curly-top of sugar beets was undertaken by the Bureau of Entomology, Truck Crop Investigations, Washington, D. C. and the writers are deeply indebted to Dr. L. O. Howard, Mr. J. E. Graf and Mr. Walter Carter. The salt bushes (*Atriplexes*) were kindly determined by Dr. H. M. Hall, Carnegie Institution of Washington.

THE DIPTEROUS PARASITES OF THE MIGRATORY LOCUST OF TROPICAL AMERICA, *SCHISTOCERCA PARANENSIS* BURMEISTER

By J. M. Aldrich, *U. S. National Museum*

In 1925 I had occasion to examine and identify a considerable collection of Diptera reared by Dr. Alfons Dampf from the above locust, which is a serious pest from Argentina to the latitude of Vera Cruz. In the spring of 1926, I spent two months in Guatemala, where my attention was called to some parasites by Mr. J. G. Salas, Director-General of Agriculture; I also made some observations in the field

among the locusts. After my return I had some correspondence which increased my information on the subject.

The following notes seem to be worth recording for the use of others, as the host is of great economic importance in the American tropics.

Oedematocera dampfi Aldrich

Oedematocera dampfi Aldrich, Proc. Ent. Soc. Wash., vol. 29, 1927, p. 17.—Greene, ibidem, p. 18, figs. larva and pupa.

In 1924 some very peculiar larvae were sent in by Professor Herrera, of Mexico City, which had been taken from specimens of the Migratory Locust; we asked especially to have specimens of the adult fly, and he sent the present species. In the following year Dr. Dampf sent in a considerable number of adults, with puparia, from the same host. In visiting Guatemala, I called upon Mr. J. G. Salas, Director-General of Agriculture, shortly after my arrival in the capital, and he showed me more of the same easily-recognized puparia, which had come from locusts in the country. I did not myself come in contact with this species of parasite in my short stay in the country, but after my return I received adult flies from Mr. Salas, and parasitized locusts from Mr. C. M. Rouillard, sugar grower at La Providencia, Siquinala, Guatemala (on the west slope below the volcano Fuego). Mr. Rouillard also informed me that at his place the locusts congregated in the trees at night in their usual manner, and in the morning he could collect "any quantity" of the white larvae of this parasite on the ground under the trees; in a few hours they had changed to the puparium. The locusts were not immediately killed, but flew away.

It is apparent from the wide distribution of this species in Mexico and Central America and its occasional large numbers that it may become a very important factor in controlling the migratory locust.

The locusts sent in fluid by Mr. Rouillard were fifteen in number, six being unparasitized, the other nine all containing from one to three larvae of *dampfi;* one specimen contained one *dampfi* and two of a Sarcophaga, presumably *caridei*. In spite of the highly specialized appearance of the stigmal plates in *dampfi* larvae, I found the maggots lying free in the abdominal cavity, always close under the posterior end of the alimentary canal; if several were present, they were as close as possible to that position. None of the parasitized female locusts that I cut open contained any eggs in recognizable form. I am unable to say from present knowledge how long a parasitized locust can live, nor whether a female can lay eggs if attacked. From what is known

of other parasites, it would seem a very remote possibility that eggs would develop in the abdomen occupied by one or more maggots.

The reproductive habit is unknown beyond what is indicated.

Sarcophaga caridei Brethes

Sarcophaga caridei Brethes, Anales Mus. Nac. Buenos Aires, viii, 1906, 299, figs.; xxii, 1912, 441, syn.—Dawe, Revista Agricola, Bogota, ii, No. 3, 143–150, 1916.

Nemoraea acridiorum Weyenb., Conil, Bol. Acad. Nac. Cordoba, iii, 1881, 426, pl. v. and vi.—Lahille, Anales del Ministerio de Agricultura, Seccion de Zootechnia, etc., Tomo iii, 1907, No. 4, 38, 50, 67.

Sarcophaga angustifrons Aldrich, Sarcophaga and Allies, 1916, 142, fig.

Brethes gave a good figure of the genitalia, from which I suspected the synonomy of my *angustifrons;* recently at my request he very kindly sent me type specimens of *caridei*, from which I confirmed it. He found the species a very abundant parasite of *Schistocerca paranensis* Burmeister, in northern Argentina; I described my species from Tifton, Georgia, and Socorro, New Mexico. Thus it appears that the fly extends over the whole range of the locust and at the north considerably farther; in its northern extension it no doubt attacks other species of locust, but no records have been made.

The species belongs to a small group of Sarcophagas which are strictly parasitic as far as known, and usually on locusts. I identified 71 Mexican specimens for Dr. Dampf, and several Guatemalan for Mr. Salas, reared from the Migratory Locust. I found several males sitting on stones on the site where a swarm of locusts had recently departed, in the Valley of the Rio Chixoy near San Cristobal, Guatemala. Considering these facts and the abundance in Argentina, this may be considered the most important known parasite of the locust, with the possible exception of *Oedematocera gilvipes* Coquillett.

Sarcophaga sternodontis Townsend

Sarcodexia sternodontis Townsend, Jour. Inst. Jamaica, i, 1892, 106, and 1893, 221.

Sarcophaga concinnata Williston, Trans. Ent. Soc. London, 1896, 364.—St. Vincent, W. I.

Sarcodexia sp., Nocedo, Proc. Second Pan-Amer. Sci. Congress, iii, 1917, 877.

Sarcophaga sternodontis Aldrich, Sarcophaga and Allies, 1916, 265.—Brauer and Bergenstamm, Zweifl. Kais. Mus., vi, 1893, 193.—Drake, Quart. Bull. State Plant Bd. Fla., iv, 1920, 75, fig.—Johnson, List Ins. of Jamaica, 1919, 439.—Morgan and McDunnough, Farmer's Bull. 819, U. S. Dept. Agr., 1923, p. 6.—Van Zwaluwenberg, Jour. Econ. Entom., xvi, 1923, 227.—Wolcott, Jour. Dept. Agr. of Porto Rico, 1922, 49; List Ins. Porto Rico, 1923, 225.—Greene, Proc. U. S. Nat. Mus., 66, art. 29, 1925, fig.

Sarcophaga sarraceniae Riley, in Comstock, Rept. Commissioner of Agriculture, 1881, 304.—Riley, Fourth Rept. U. S. Entom. Commission, 1885, Appendix, p. 110.

This abundant tropical species comes as far north as the region around the north side of the Gulf of Mexico, and is found at least as far south as Brazil. In the collections sent me for identification by Dr. Dampf, were 201 specimens of this species, mostly reared from the migratory locust, but generally from dead specimens which might not have been attacked by the fly while still alive. It is therefore impossible to say just what importance this species has as a locust enemy. It seems worth while to analyze the available records to get as complete a picture as possible of the larval habits of the species. We have some positive evidence that it is a true parasite, and I think it usually is; but we have also some records which cannot be so interpreted, and many not definite. The crucial question in every case is whether the fly deposited its larvae upon a living insect or a dead and decomposing one. In the United States we have *Sarcophaga helicis* and *sarracenioides*, if not others, which are certainly scavengers at times and at others true parasites; *sternodontis* evidently belongs with these in habit.

We have the following rearing records for *sternodontis:*

ORTHOPTERA

Schistocerca americana Drury, in Florida (Aldrich, 1916).
Dictyophorus reticulatus Thunberg, in Florida (Aldrich, 1916).
Scapteriscus vicinus Scudder, in Porto Rico (Wolcott, 1922).[1]
"Dead Cockroach," in Porto Rico (Unpublished, specimen in Nat. Mus.).
"A large gray-brown mottled Cockroach," in Porto Rico (Unpublished, bred by Dr. F. M. Root; the cockroach is probably *Leucophaea maderae* Fabricius, in the opinion of A. Caudell).
"Large Grasshopper," in Panama (unpublished, reared by August Busck).

HEMIPTERA

Nezara viridula Linnaeus, in Florida (Drake, 1920).
Coreocoris confluentus Say, in Florida (Drake, 1920).
Acrosternum hilaris Say, in Florida (Drake, 1920).
Murgantia histrionica Hahn, in Florida (Drake, 1920).
Euschistus servus, Say in Florida (Drake, 1920).
Belostoma sp. in Panama (unpublished, reared by A. H. Jennings).

LEPIDOPTERA

Alabama argillacea Huebner, in Southern States (Comstock, 1881; Riley, 1885, also an unpublished rearing by G. D. Smith).
Citheronia regalis Fabricius, in Florida (Aldrich, 1916).
Remigia repanda Fabricius, in Porto Rico (Wolcott, 1922).
Cossula magnifica Strecker (unpublished rearing by J. B. Gill).
Phlegethontia sexta Johannsen, in Florida (unpublished record, rearing by F. S. Chamberlin).
Chloridea obsoleta Fabricius, in Salvador (unpublished record, rearing by S. Calderon).

[1]The name of the fly was omitted in Wolcott's List, but added in his supplement

Chloridea sp., in Florida (unpublished, rearing by J. N. Tenhet).
Erynnis allo Linnaeus (unpublished, reared by J. Zetek) in Canal Zone, Panama.
Heliothis virescens Fabricius, in Southern States (Morgan and McDunnough, 1923).
Laphygma frugiperda Smith and Abbott, in Porto Rico (Wolcott, 1922).
Autographa brassicae Riley, in Louisiana (unpublished, reared by T. H. Jones).
Diatraea saccharalis Fabricius, in Cuba (Van Zuwalenberg, 1923).
Diatraea lineolata Walker, in Mexico (Van Zuwalenberg, 1923).
Acronycta ovata Grote, from Cadet, Missouri (unpublished, reared by Lugger, Bur. Ent. No. 508 L).
Diaphania hyalinata Linnaeus, from Macon, Georgia (unpublished, reared by Pergande, Bur. Ent. No. 225a).
Calpodes ethlius Cramer, in St. Vincent, West Indies (unpublished, reared by F. Watts).
"Caterpillar on Cotton," Tobago, West Indies (unpublished, reared by F. Urich).

COLEOPTERA

Sternodontes damicornis Linnaeus (Townsend, 1892).
Stethoxus foveolatus Reginbart "Especie evolucionada en el cuerpo descompuesto," in Ecuador (unpublished, reared by Professor F. Campos R.).
Lachnosterna portoricensis Smyth, in Porto Rico (Wolcott, 1923).
Strataegus sp., adult, in Jamaica (unpublished, reared by A. H. Ritchie).

MISCELLANEOUS

Human Excrement, in Hayti (unpublished, reared by W. A. Hoffman).
"Larva from Ear of 11-months old Child," in Canal Zone, Panama (unpublished, specimen sent by L. H. Dunn).
"From Case of Myiasis," in Belize, British Honduras (unpublished, sent from Liverpool School of Tropical Medicine).
"On dead Mygale," in Trinidad, West Indies (unpublished, collector unknown).
Centrurus edwardsii Gray (a myriopod), in Jamaica (Townsend, 1893).

The specimens sent by Dr. F. M. Root, were found as larvae in freshly killed cockroaches which were being dissected. The specimen reared by Wilson from *Schistocerca americana* reported by me in 1916, was reared from larvae that emerged after the grasshoppers were killed, pinned, and placed in a tight insect box. These records are sufficient to prove that the fly is sometimes a true parasite, depositing its larvae upon living insects; and there is little reason to doubt that a large proportion of the above records represent cases of genuine parasitism. Several of the other records, especially the rearing from human excrement, indicate that it is sometimes a scavenger.

From the discussion it will be apparent that the value of *sternodontis* as a locust parasite is at present not known.

Brachycoma acridiorum Weyenbergh

Nemoraea acridiorum Weyenbergh, Anales de Agricultura Repub. Argentina, iii, 1875, 85 (also called Doringia acridiorum in same place), figs.—Lahille, Anales

Ministerio de Agricultura, Seccion Zootechnia, etc., 1907, 38, 48, quotes desc. with orig. fig.
Sarcophaga minuta Lahille, ibidem, 82, 86, figs.
Brachycoma acridiorum Brethes, Anal. Mus. Nac. Hist. Nat. Buenos Aires, xxii, 1912, 445, figs., redesc.

The original description was so poor that great uncertainty prevailed for many years as to the correct identification. After Brethes had described *Sarcophaga caridei* in 1906, Lahille was still of the opinion that this species was the same as *acridiorum*, in spite of obvious discrepancies in the original description. So he failed as Brethes believes to observe that one of his own new species, *Sarcophaga minuta*, from the same host, really answered the description of Weyenbergh far better than any other known locust parasite. I follow the conclusion of Brethes in the synonomy, and accept his 1912 determination, from which *acridiorum* is clearly a Brachycoma. He figures the head very well, and Lahille the genitalia.

This appears to be an important parasite of the locust in Argentina, but is not as yet known in tropical North America.

A YEAR'S TEST OF A SO-CALLED "FLY SALT"[1]

By L. C. Aicher, R. H. Lush, and Roger C. Smith,
Kansas Agricultural Experiment Station

Abstract

A salt mixture termed "fly salt," containing 9.77% free sulphur, has been sold extensively throughout the middle west, under the representation that when fed to cattle, enough sulphur was excreted with the perspiration to prevent flies from biting the cattle, thereby resulting in greater gains to beef cattle and preventing losses in milk flow from fly attacks. Two experiments were carried out by the Kansas State Agricultural College—one at the Hays Station with a herd of 20 high grade Hereford yearlings against a comparable herd kept under the same conditions fed common salt; the other with four dairy cattle at the Kansas Agricultural Experiment Station fed the "fly salt" against animals fed common salt which was sulphur free. The gain in weight in the yearlings in 156 days was approximately equal and the dairy cattle fed the "fly salt" showed a very similar decline in milk flow to the check animals. The salt was, also wholly ineffective as a fly repellent. The fly salt cost six times that of the common salt, and was not relished by the animals.

[1]Contribution No. 359, from the Entomological Laboratory (Dairy contribution No. 58), Kansas State Agricultural College. Valuable assistance was given those responsible for carrying out the tests by Dean L. E. Call, Prof. Geo. A. Dean, Dr. C. W. McCampbell, and Prof. J. B. Fitch. The Hays experiment was carried out by Mr. Aicher; the dairy test by Mr. Lush. Observations on the flies were made by Mr. Smith, who prepared this paper from the three reports.

The wide advertising given a new salt product prepared by one of the largest salt companies in the United States, brought the product rather forcefully to the attention of the Kansas Agricultural Experiment Station. This salt, when fed to cattle, was said to prevent flies from biting the cattle, resulting in less annoyance and greater gains in weight or increased milk production. Many letters inquiring as to the fly repellent qualities of this salt were received. Experimental evidence as to its effectiveness was not available, though the company was reputed to have received testimonials from farmers and cattle-men substantiating its claims of fly-repelling qualities. In order to determine the actual value of the new salt product, a carefully planned test was conducted at the Fort Hays Experiment Station with beef cattle, and a smaller scale test with dairy animals at Manhattan. This is a brief summary of these experiments, and the results obtained. Since it requires considerable time to carry on such tests, since letters of inquiry concerning "fly salt" are still being received, and since further study of this question is not now contemplated, it was thought that these results should be made available by publication.

OUTLINE OF EXPERIMENT AT HAYS EXPERIMENT STATION

In order to arrive at a fair conclusion as to the value of the "fly salt," it was determined that two closely similar lots of cattle would be used — one lot was fed common salt and the other was fed the "fly salt." The cattle were weighed into separate though similar pastures, and weighed out at the close of the experiment. Any significant gain or loss in weight was to be noted at the end of the test. It was felt that if the "fly salt" actually had the quality of preventing flies from biting cattle, it would be registered in a practical way by a greater gain in weight in the group fed the fly repellent salt; it was also to be determined if the gain was sufficient to pay for the increased cost of the new salt. The original plan of the experiment called for exchanging cattle in the pastures every thirty (30) days to overcome any advantage which one group of cattle might have over the other, due to possibly better pasture in one field than in the other, or to more flies in one pasture than the other, but, beginning July 1, the exchange was made every three weeks. The salt was placed in long wooden troughs, and the cattle were given all they would eat. When the cattle were moved to the alternate pastures, the salt was also exchanged. The amount of salt fed was weighed and recorded. Observations as to behavior of the groups were made at convenient intervals throughout the experiment, which lasted from May 1st to October 15, 1926.

TABLE 1.—ANALYSIS OF THE SALT USED IN THESE TESTS

1. Barton's Fly Salt—Analysis by the Federal Insecticide and Fungicide Board, No. 50974, Misc. Div.

Free sulfur, S	9.77%
Chlorine, Cl	53.31
Sodium, Na	34.39
Calcium oxide, CaO	1.55
Carbon Dioxide, CO_2	0.53
	99.55%

Hypothetical Combination of the above in the "fly salt."

Free sulfur	9.77%
Sodium chloride, NaCl	87.89
Calcium carbonate, $CaCO_3$	1.21
Calcium hydroxide $Ca(OH)_2$	1.15
	100.02%

Phosphates—none
Charcoal—none

2. Analysis of the common salt fed, by Prof. W. L. Latshaw, Kansas State Agricultural Experiment Station, Department of Chemistry.

Sulfur	None
Sodium chloride	96.23%
Insoluble matter	1.78
Moisture	0.15
Calcium sulfate (Gypsum)	1.51
Magnesium chloride ($MgCl_2$—6 H_2O)	.03
Total determined	99.70%
Undetermined	.30
Total	100.00%

The salt, when first put on the market, contained approximately 5% of carbon (charcoal), but later this was replaced by 5% lime. It was claimed by the company that the lime had the function of causing the sulphur to be more readily and completely absorbed in the gastro-intestinal tract of the animal, but there is no physiological basis for this claim.

THE EXPERIMENT. Forty well-bred Hereford yearlings—20 steers and 20 heifers—were divided into two groups composed of 10 heifers and 10 steers each. These groups were weighed early in the morning, three days in succession, and the average weight of the cattle for the three-day period computed and accepted as the true initial weight of the groups. The cattle were then taken to the pastures on May 1st—

one group to the so-called "golf" pasture, comprising approximately 280 acres of native prairie grass, and fed "fly salt" manufactured by the Barton Salt Company, and sold to the Experiment Station by the Farmers Co-operative Elevator Company of Quinter, Kansas. The price paid for the salt was $2.40 per hundred pounds, F.O.B. Quinter, Kansas. The other group was taken to the "old dairy" pasture, comprising approximately 275 acres of native prairie grass, and was given common salt, which was a product of this same company and was also purchased locally.

On July 21st, the "old dairy" pasture was abandoned and the herd moved to the "Monument" pasture. This pasture consisted of about 320 acres of native prairie grass and was well supplied with shade and natural creek water. This pasture was somewhat superior to the "golf" pasture, because of a greater amount of shade and the presence of the creek. However, each herd was in the pasture an equal number of days.

Twenty head of Holstein calves were kept with the herd fed common salt until August 11th. On this date they were removed, since there was a theoretical possibility that a larger herd might attract an increased number of flies.

The experiment was begun on May 10, and the cattle were exchanged June 10, July 1, July 21, Aug. 11. Sept. 2, Sept.22, and weighed into the feed lots on Oct. 13, 14 and 15. The average weights for the three-day period being taken as the true weight of the cattle.

Experimental Data. The dates and amount of salt taken to the the pastures are given below:

Table 2.—Pounds of Salt Fed and Consumed by the Two Herds in the Course of the Experiment

Date	Fly salt	Common salt	
May 10	50	48.7	Average consumption for 20 head*
June 10	20	20.3	
July 21	46	52	
Aug. 11	9	16	
Sept. 4	16	10	
Oct. 13	13 lbs. weighed back	15 lbs. weighed back	
Total Consumption	128 lbs.	132 lbs.	
Average daily consumption per head	.656 oz.	.676 oz.	

*There were 37 head of cattle in this group, in addition to the 20 experimental animals, from May 10 to July 21, inclusive. The salt which the 20 experimental cattle consumed is figured on the basis of the average for the 57 head.

TABLE 3.—WEIGHTS OF CATTLE IN THE TWO LOTS IN THE "FLY SALT" EXPERIMENT

	Fly Salt 20 head {10 steers, 10 heifers}	Common Salt 20 head {10 steers, 10 heifers}
Total initial weight, May 10	12,300 lbs.	11,910 lbs.
Average weight per animal, May 10	615 lbs.	595.5 lbs.
Total final weight, October 13	15,720 lbs.	15,428 lbs.
Average weight per animal, Oct. 13	786 lbs.	771.4 lbs.
Total gain per lot for 156 days	3,420 lbs.	3,518 lbs.
Average gain per animal for 156 days	171 lbs.	175.9 lbs.
Average daily gain per animal	1.09 lbs.	1.12 lbs.

OBSERVATIONS Definite dates for observations of behavior of the cattle were not provided for in the plan of the experiment, but many visits were made to the pastures during the season. The pastures were somewhat below the average, due to persistent drought. The precipitation records show that the season was 5.44 inches below the normal at the end of September. Flies were not as plentiful as usual, partially due, no doubt, to the shortage of moisture, but there were sufficient numbers to keep the animals fighting them almost constantly.

Observations were made on the behavior of the cattle with reference to flies; long distance observations upon the flies with the aid of field glasses, since the animals were so wild that near approach was impossible; and careful examination of flies caught from the two herds. Horn flies generally predominated, but stable flies were also numerous.

Some actual counts of fly-fighting activities of the animals in both herds were made (see Table 4). The animals were always very restless

TABLE 4.—COMPARISON OF FLY-FIGHTING ACTIVITIES OF SIX ANIMALS IN THE TWO HERDS FOR FIVE-MINUTE INTERVALS

Period activities counted for each animal	Herd fed common salt: Switches	Kicks	Head swipes	Position of animal	Herd fed "fly salt": Time	Switches	Kicks	Head swipes	Position of animal
Aug. 10, '26 10:59–11:04	90	10	5	in herd	9:40–9:45	55	19	8	in herd
Aug. 10, '26 11:08–11:13	93	3	13	slowly walking	9:47–9:52	79	15	1	in herd
Aug. 10, '26 11:20–11:25	70	6	6	in herd	10:58–11:03	160	32	20	sep'r't'd from herd
Average	84.3	6.3	8			98	22	9.6	

and kept milling around in the herd, so that counts for longer periods than used were impossible.

One could readily tell when flies were actually biting the animals and when they were merely resting on the hair of the animal. When biting, the flies were lower down among the hairs. Often they were distinctly tilted forward and their wings were spread out slightly in a manner different from their position at rest.

On August 6, we tried to catch flies from both herds and make counts of the fly population of the two herds and the number of species involved, but the animals were so wild that near approach by any means was impossible. A small barbed wire pen was built in a corner of each pasture, and on Aug. 27, 1926, an attempt was made to collect flies from each herd with the aid of an insect net. Only 121 horn flies were collected from the check herd, and 64 from the "fly salt" herd (see Table 5). The animals milled around in the pens, raising clouds of dust and finally broke through the wire enclosures and escaped. The flies do not represent the population on the animals adequately as to species or numbers. There was a much higher proportion of female than male flies.

TABLE 5.—EXAMINATION OF HORN FLIES TAKEN FROM THE HERDS, AUG. 27, 1926

	Number of flies taken	Number female flies	Number of females with blood	Number of males	Number of males showing blood
Fly Salt herd......	64	47	27	17	5
Common salt herd.	121	87	45	34	25

No real difference in the fly-fighting activities was observed in the two herds at any time during the experiment. Photographs made at various times during the experiment, of which Plate 17, Figs. 1 to 4, inclusive, are given here, support this statement.

On August 6, it was thought that the coats of the "fly salt" herd were somewhat improved in appearance over the common salt herd. The thirty-seven Holstein calves were with the common salt herd, and it was thought possible that the observers might have been influenced by the presence of the less sleek and glossy Holsteins. This supposed

EXPLANATION OF PLATE 17

FIG. 1.—The common salt herd in the "Monument" pasture. Aug. 1, 1926.
FIG. 2.—The "fly salt" herd in the same pasture, Aug. 22, 1926.
FIG. 3.—The "fly salt" herd in the "golf" pasture, Aug. 1, 1926.
FIG. 4.—The common salt herd in the "golf" pasture, Aug. 22, 1926.

Note the fly-fighting activities in both herds.
Photographs by Mr. Aicher.

1.

2.

3.

4.

difference in coats was not observed later when the Holsteins were removed. We prefer to leave this question open, as the experiment was not carried out with this point in the plans.

Results and Conclusions. It is believed that the very small increased gain made by the common salt cattle shown in Table 2 is within the range of experimental error, and, therefore, we conclude that the showing of the two herds is as nearly equal as one might expect. The average daily gain of the "fly salt" cattle was 1.09 pounds, and that of the common salt cattle was 1.12. pounds.

The results of the experiment indicate rather conclusively that the so-called "fly salt" is not a fly repellent. If it had been, it would have been impossible to catch flies from the bodies of these cattle, approximately fifty per cent of which carried blood in their bodies. Secondly, if the "fly salt" had repelled the flies, the cattle should have registered a greater gain in weight than when fed common salt. It is common knowledge among cattle-men that flies decrease the gains. Since the "fly salt" cattle did not show a gain over the common salt cattle, the so-called "fly salt" is worth no more per pound as salt for cattle than is common salt. The 'fly salt" at $2.40 per hundred pounds cost six times more than the common salt at forty cents per hundred.

The Dairy Experiment. In this test, the results of feeding this same salt to dairy cattle were studied. The "fly salt" used in this part of the experiment contained some charcoal, and was very dark in appearance. The analysis of this salt, as given in the Report of Analysis of Official Samples of Livestock Remedies, July 1, 1925–26, by the Kansas State Board of Agriculture, Vol 45, p. 34, No. 178, is as follows: Salt 85.35%, sulphur 10.52%, charcoal 2.8%, moisture by difference 1.33%.

Plan. Four cows were fed one and one-half per cent Homestead Fly Salt in the grain ration as compared to three check animals and the rest of the herd which received one and one-half per cent normal granulated salt in the ration. The four cows also had access to individual salt bowls at milking time which contained Homestead Fly Salt. No other salt was available, the plan being to obtain the maximum consumption of Homestead Fly Salt. The four cows used were comparable in breed and lactation period. They were handled and milked with the rest of the herd, being on pasture from 7:00 a.m. to 2:00 p.m., and during the night. The majority of the feed was consumed in the barn at milking time where silage and grain were fed.

Samples of milk from each of the cows receiving "fly salt" and from three check cows were separately cooled and observed for two days

previous to the start, and during 40 days of the experiment. The experiment started June 7th, with "fly salt" being given for the first time.

RESULTS The production of milk by 10-day periods for each lot is given in Table 6.

TABLE 6.—MILK PRODUCTION IN POUNDS OF MILK IN THE TWO LOTS OF COWS FOR 40 DAYS

Lot	Preliminary 10 days	First 10 days	% Decrease	Second 10 days	% Decrease	Third 10 days	% Decrease 30 days	Fourth 10 days	% Decrease 40 days
Fly salt group..	481.0	378.9	21.2	310.6	35.4	271.1	43.6	228.8	52.4
Check lot.	421.4	326.1	22.6	276.7	34.3	250.4	40.5	217.0	48.5
Difference.	59.6	52.8		33.9		20.7		11.8	

The decline of 252.2 pounds of milk in 40 days for the three cows receiving "fly salt" as compared to the smaller decline of 204.4 pounds in the check lot for the same period, indicates that the "fly salt" was no more effective in preventing the usual decline in the milk flow than was ordinary salt. This is contradictory to the advertisement of the manufacturers of this product. The estimated average number of flies on the left side of representative animals of each group is given in Table 7.

TABLE 7.—AVERAGE NUMBER OF FLIES PER DAY ON EACH COW WHILE IN THE STABLE

Lot	First 10 Days	Second 10 days	Third 10 days	Fourth 10 days	Fifth 10 days	Ave. for 50 days
Fly salt......	35	37	18	12	10	22
Check........	29	34	18	16	14	22

The smaller number of flies during the last 30 days can be attributed to the extremely hot and dry weather with lessened opportunity for breeding and possibly fewer flies. It was noticed that on extremely hot days the flies did not attack the cows, but withdrew to the north wall of the barn.

It was suggested by a salesman of the "fly salt" company that the flies were not annoying the cows, but simply resting. It was determined that the species of flies in the stable in order of abundance were the stable fly, horn fly and house fly. It was found by mashing the first two species of flies collected on the experimental animals that a rather high percentage of them contained blood.

INFLUENCE OF FLY SALT ON THE TASTE OF THE MILK. In checking the effect of the "fly salt" on the taste of milk, surprising results were obtained. All of the samples were normal in taste during the preliminary two days,

but by the afternoon milking of the first day "fly salt" was given, two of the three samples were distinctly salty and continued to be off flavor. Each sample was tasted immediately after cooling and 24 hours later, in order to notice any further change. The results are given in Table 8.

TABLE 8.—EFFECT OF SALT ON FLAVOR OF MILK

	Group 1—Fly salt cows				Group 2—Common salt cows				
Period	Cow 1	Cow 2	Cow 3	Cow 7	Cow 4	Cow 5	Cow 6	Total	
Preliminary 2 days	3 tests	3 tests	3 tests		3 tests	3 tests	2 tests	17 tests all normal	
								Group 1	Group 2
June 7–28									
Normal	3	31	0	Dry	27	18	21	34	66
Salty	40	12	43		1	10	1	95	12
June 29–July 5[1]									
Normal	0	14	6		13	10	11	20	34
Salty	14	0	8	Dry	1	4	3	20	8
July 19–22									
Normal		6	0	7		7	1	13	8
Salty		1	7	0		0	6	8	6
Total Normal								67	108
Total Salty								123	26

[1]Cows 4 and 5 given one ounce salt per feed.

At no time during the three months were the cows observed in the act of eating "fly salt" from the salt bowls, although there was a slight loss when weighed back September 5. The "fly salt," when offered to young stock not receiving other salt, was consumed reluctantly, three days elapsing before it was touched.

RESULTS. As a result of a three months' trial with four cows fed Homestead Fly Salt, it was observed that those cows did not differ materially, in production of milk or freedom from fly annoyance, from other cows fed normal salt and handled in a similar manner.

The three cows that were milking declined 52.4 per cent in milk flow from various causes as compared to a decline of 48.5 per cent for three similar cows fed normal salt during the period of 40 days.

The average number of flies observed daily on the left side of each animal averaged the same for each lot for the 50 days observations were made.

It is possible that fly salt has an injurious effect on the flavor of the milk. We do not consider this point as definitely proved, as there are certain uninvestigated physiological problems involved. It was discovered in September that cow No.1 had mammitis, which normally renders the milk bitter or salty to the taste. But, omitting the samples

obtained from cow No.1, we find that in the "fly salt" lot, 67 of the 133 samples were salty as compared to 26 out of 134 in the normal group.

The Metabolism of Sulphur in Mammals

Sulphur is the ingredient in the salt alleged to repel the flies. It is, however, well known to physiologists that elemental sulphur is not absorbed in the alimentary tract, except in minute quantities. Sulphur is absorbed by the body chiefly in the form of the two amino acids—cystine and cysteine decomposition products of protein. The sulphur probably practically all passed through the body unchanged. The amount of sulphur in the body remains relatively constant, and is not greatly influenced by the sulphur containing proteins in the diet. Cushney (1918)[1], states that while the greater part of free sulphur consumed is excreted unchanged, some of it forms sulphides in the mucous membrane of the intestine, and these cause irritation. "Some 10–20% of sulphur taken by way of the mouth is absorbed as sulphides, which is excreted to a small extent by the lungs . . . and to a much larger extent by the urine as sulphates and in organic combination." There is, therefore, no physiological basis whatever for expecting "fly salt" to be excreted in sufficient quantities with the perspiration to repel flies. While it is possible that some of the sulphur compounds may be excreted with the perspiration, there is no scientific evidence that this is the case. The first opinions expressed by officials of this institution were based on this knowledge, but tests seemed advisable because of users' testimonials.

General Results and Conclusions

As a result of these two tests, we conclude, in the case of this "fly salt," that:

1. It was without value for the purpose recommended. Animals fed all the salt they would eat were tormented by flies to the same extent as those fed common salt, and that approximately the same percentage of flies caught on the animals contained blood which was unquestionably derived from the cattle.

2. There was no gain in weight over those fed ordinary salt as a result of feeding "fly salt," and the milk flow was not appreciably influenced by it.

3. Cattle did not relish it as much as they did ordinary salt.

4. There is a possibility in some animals or under some conditions of influencing the taste of the milk. The salty milk detected during the dairy test is an apparently new problem, and it is not understood.

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[1]Cushny, Arthur H. A text book of Pharmacology and Therapeutics. . .Lea and Febiger, 1918. (Reference on p. 94–95.)

FURTHER INFORMATION ON A CONTACT SPRAY FOR THE CONTROL OF THE JAPANESE BEETLE (*POPILLIA JAPONICA* NEWM.[1]

By E. R. VAN LEEUWEN, *Associate Entomologist*, and P. A. VAN DER MEULEN, *Agent*, *Bureau of Entomology, United States Department of Agriculture.*[2]

ABSTRACT

The purpose of this paper is to record the improvement made in the sodium oleate-oleoresin of pyrethrum spray for the control of the Japanese beetle by the addition of sodium silicate.

INTRODUCTION

In a preliminary report,[3] a tentative formula for a contact spray consisting of sodium oleate and oleoresin of pyrethrum flowers, was presented. Data on its use in controlling the Japanese beetle were included. The purpose of this paper is to give additional data on the improvement of the spray, based on experiments conducted during 1926.

ISECTICIDAL VALUE OF CONTACT SPRAY

During the past beetle season, according to the reports of several manufacturers of the spray, approximately twenty-two thousand dollars worth of the contact spray consisting of the oleoresin of pyrethrum flowers and sodium oleate was used throughout the heavily infested section of the beetle area with very satisfactory results. It was estimated that millions of beetles were destroyed by use of the spray. The past season's experience with the contact spray again demonstrated the fact, pointed out in the earlier report, that the controlling factor in the percentage of kill obtained with a spray of this type against the Japanese beetle, is the thoroughness with which the application is made. The size and structure of the beetle, as well as the nature of the effect of a spray of this character upon the beetle, necessitates that the application be thorough.

In several cases low kills were reported from the use of the spray. Upon investigation it was determined that the lack of a sufficient coating of this spray mixture to cover the beetles was accountable for this. These few cases of low kill resulting from inefficient mechanical operation of the spray can be more readily understood when one considers

[1]Contribution No. 23 of the Japanese Beetle Laboratory, Riverton, N. J.

[2]The writers are not attempting in this paper to set forth a finished formula; but, in view of the interest shown in a spray of this type, the data obtained from laboratory tests are presented at this time.

[3]Van Leeuwen, E. R. A contact spray for the control of the Japanese beetle. Jour. Econ. Ent., Vol. 19, No. 5, Pages 786–790. 1926.

that most of the spray was used in the residential districts of Philadelphia, Pa., and Camden, N. J., by people who lacked experience in the method of applying sprays or were not acquainted with the results to be expected from the application of a contact spray.

It has been proved that a contact spray has considerable value in combating the Japanese beetle, and investigations were therefore continued during the 1926 beetle season with sprays of this nature.

Purpose of The Tests

Besides the testing of materials of promising and of unknown value for sprays against the beetle, several materials were added to the combination of oleoresin of pyrethrum flowers and sodium oleate in an endeavor to increase its toxicity, to cheapen its production, and to improve its effectiveness in general.

Experimental Procedure

A uniform method of testing the sprays in cages, as recorded in the report on the contact formula, was used.[3] The conditions under which the sprays were applied were similar for each series, this arrangement being necessary for the purpose of comparing the effectiveness of the different materials.[4] Since the original formula, when applied to beetles in cages, gave nearly 100 per cent kill, it was necessary, for purposes of comparison of the various materials, to use a less concentrated solution. The formula to which the materials were added will hereafter be referred to as Formula A and is as follows:—An alcoholic extract of pyrethrum flowers 9½ ounces, sodium oleate 86½ ounces, and water 100 gallons. The materials which were thought to be of value in improving the formula and tested were as follows:—Kerosene, various grades of cresylic acid, glycerine, carbon tetrachloride, sodium silicate and gum arabic. With the exception of the tests made with sodium silicate and Formula A, the results were more or less negative, and since no apparent improvement in the toxicity of the spray resulted from the addition of the other materials, only the results obtained with the sodium silicate are given. The results obtained by the addition of the sodium silicate to Formula A are given in Table 1, as well as the results from tests with untreated beetles and beetles treated with Formula A without the sodium silicate. The "sodium silicate," as used in this spray, refers to a solution of the following composition:

Na_2O	9.01%
SiO_2	28.35%
H_2O (by diff.)	62.64%

[4]The writers wish to acknowledge the assistance of Mr. G. A. Fails in carrying out the spray tests.

TABLE 1.—COMPARISON OF RESULTS FROM TESTS WITH VARIOUS AMOUNTS OF SODIUM SILICATE ADDED TO SODIUM OLEATE-OLEORESIN OF PYRETHRUM SPRAY

Series No.	Date	Formula A[1] Total No. of beetles	Formula A[1] Mortality Per cent 24 hrs.	Formula A[1] Mortality Per cent 48 hrs.	Formula A and sodium silicate solution 3 fluid ounces Total No. of beetles	3 fl. oz. Mortality Per cent 24 hrs.	3 fl. oz. Mortality Per cent 48 hrs.	Formula A and sodium silicate solution 6 fluid ounces Total No. of beetles	6 fl. oz. Mortality Per cent 24 hrs.	6 fl. oz. Mortality Per cent 48 hrs.	Formula A and sodium silicate solution 9 fluid ounces Total No. of beetles	9 fl. oz. Mortality Per cent 24 hrs.	9 fl. oz. Mortality Per cent 48 hrs.	Formula A and sodium silicate solution 12 fluid ounces Total No. of beetles	12 fl. oz. Mortality Per cent 24 hrs.	12 fl. oz. Mortality Per cent 48 hrs.	Untreated beetles (Check) Total No. of beetles	Check Mortality Per cent 24 hrs.	Check Mortality Per cent 48 hrs.
1	Aug. 11	192	31	59	312	36	57	176	81	98	181	63	82	148	89	95	191	3	12
2	Aug. 12	201	79	85	284	68	81	203	93	96	192	71	87	206	76	87	189	3	12
3	Aug. 14	185	32	42	397	86	93	383	77	87	393	76	86	401	80	89	193	5	10
4	Aug. 16	422	41	68	388	46	78	386	62	86	286	74	86	193	59	88	190	6	26
5	Aug. 18	363	29	53	395	11	32	426	43	55	391	44	57	361	62	86	197	5	22
6	Aug. 19	198	58	80	215	33	51	207	71	91	326	82	97	352	77	87	204	5	12
7	Aug. 24	388	74	86	395	62	80	384	75	87	384	70	93	397	69	89	98	19	37
Average for series			49	67		48	68		71	85		68	84		73	88		6	18

[1]Formula A is as follows: An alcoholic extract of pyrethrum flowers 9½ ounces, sodium oleate 86½ ounces and water 100 gallons.

Results

For the purpose of summarizing the results and drawing deductions an average percentage of kill for 24 hours and 48 hours after application is calculated from all of the observations throughout the year's tests. The data in Table 1 show strikingly the effect of adding 6 ounces of sodium silicate solution to the spray composed of oleoresin of pyrethrum and sodium oleate. The results in percentage of kill of the different solutions as shown in Table 1 are as follows:—Formula A which contained no sodium silicate whatsoever gave an average kill of 49 per cent at the end of the 24 hour period after treatment and 67 per cent for the total period of 48 hours. Formula A to which three ounces of sodium silicate solution had been added gave 48 per cent kill for the 24 hour period and 68 per cent within 48 hours. An increase in the sodium silicate solution content to 6 ounces gave an average kill of 71 per cent for the first 24 hours after the beetles were sprayed and 85 per cent at the end of a 48 hour period. Thus it is shown that 6 ounces of sodium silicate solution added to formula A increased its toxicity by 22 per cent and 18 per cent for the 24 and 48 hour periods, respectively. As will be seen by an examination of the death rate among the untreated beetles, an average of 6 per cent died in 24 hours and 18 per cent within 48 hours. By increasing the sodium silicate solution in the spray to 9 ounces, the average kill obtained was 68 per cent for the 24 hour period and 84 per cent within 48 hours. Twelve ounces of sodium silicate solution added to formula A resulted in an average kill of 73 per cent and 88 per cent for the 24 and 48 hour periods, respectively. From these results it will be seen that the greatest efficiency of the sodium silicate, under the conditions reported above, centers close to the 6 ounce rate.

Laboratory studies are being made on the physical and chemical structure of the various combinations of the soaps and sodium silicate in an endeavor to find a satisfactory explanation for the results recorded above.

Summary

While a contact spray of oleoresin of pyrethrum flowers and sodium oleate has proved effective in killing the Japanese beetle, further experiments were made to increase its toxicity, to lessen its cost, and to improve its effectiveness in general.

The addition of 6 fluid ounces of sodium silicate solution to a mixture composed of 86½ ounces of sodium oleate, 9½ ounces of oleoresin of pyrethrum flowers and 100 gallons of water resulted in a very striking increase in toxicity.

Further studies are contemplated to determine the physical and chemical structure of the spray in order to utilize the sodium silicate more effectively in combating the Japanese beetle.

A STUDY OF ARSENICAL RESIDUES ON APPLES IN PENNSYLVANIA WITH RESPECT TO EFFICIENT SPRAYING PRACTICES[1]

By G. F. MacLeod, D. E. Haley and R. H. Sudds, *The Pennsylvania State College, State College, Penna.*

ABSTRACT

Insect species attacking apples in Pennsylvania necessitated six arsenical spray applications. The omission of one or more of these treatments resulted in increased injuries to the fruits. Satisfactory protection was obtained during 1926 without excessive arsenic occurring on the apples at harvest time. Rains in excess of normal tended to reduce the amount of spray deposit. Visibility of materials was no indication of the relative amounts of residual arsenic.

INTRODUCTION

Apples of the southern and southeastern counties of Pennsylvania are subject to attacks of several insects which ordinarily feed extensively during the middle and late summer months. Codling moth outbreaks occur late in August in some years. *Eulia velutiana* Walker, the red-banded leaf-roller; *Archips rosaceana* Harris, the oblique banded leaf-roller; and *Amorbia humerosana* Clemens, are late feeders of importance, some individuals appearing in October or during November.

The damage incurred from these insects is often a source of annual losses to fruit growers, and late summer sprays containing lead arsenate are sometimes necessary for the complete protection of apple fruits from insect injury. As a result, a rather heavy coating of material sometimes remains on the fruits. A few shipments of apples have been rejected or seized, both at home and abroad because of excessive spray residues. The financial losses and embarrassment sustained by growers on account of these procedures, together with the absence of local information concerning arsenical deposits led to a study of these conditions by the Department of Entomology Extension of the Pennsylvania State College. The analyses of residues were made by the Department of Agricultural and Biological Chemistry.

OBJECT OF THE STUDY

The object of this study was to ascertain quantitatively the amount of residual arsenic present on apples which had received the minimum

[1]Approved by the Director of the Experiment Station as Technical Paper No. 434.

quantity of spray material required for the adequate protection of the fruits. This work comprised two phases,—(1) the determination of what constituted the minimum amount of arsenical spraying for complete protection and (2) the determination of arsenic in spray deposits.

Arsenical Spraying Practices During 1926

The spraying schedule as outlined in Table 1 includes the dates of applications which were advised in 1926.

Discussion

From Table 1 it will be observed that six applications of arsenical sprays were used in these sections. No arsenical was used in the delayed dormant period where oil sprays were applied. In either instance, however, the fruits received four poison sprays from the time of the petal fall treatment to the end of the spraying season.

The advisability of using arsenicals at the periods stated and in the amounts indicated is evident from the nature of the problems involved. Tent caterpillars, bud moths and leaf-rollers were unusually numerous during 1926, and a reduction in the numbers of the first generation assists greatly in preventing late summer injuries to the fruit.

Codling moth adults did not emerge in these counties at the time of the petal fall application, but ten to fifteen days later they appeared in large numbers. Coincident with this emergence, the plum curculio gave promise of unusual damages to fruits. These two factors were responsible for an emergency spray warning noted in Table 1. The usual cluster apple and summer applications were required by the presence of apple scab, together with the continued activities of the plum curculio, our common leaf-rollers, and the codling moth. The summer application was made from the middle to the last of July. Only two of the applications advised contained a spreader.

Effectiveness of Spray Applications in Commercial Orchards

The percentages of clean fruits recorded in Table 2 are only of apples which were not injured by insects ordinarily controlled by lead arsenate. As far as possible, Stayman apples were selected from vigorous, well cared-for trees in the prime of bearing condition. Orchard 16 received an application of sulfur-lead arsenate dust at the time of the last treatment. This represented an effort on the part of the grower to avoid excessive spray residues, and it is interesting to note that there was no visible residue on these apples, (see Table 3, sample No. 11). The degree of protection in this orchard was considerably less than that obtained where a liquid application was made. Orchard 17 did not

TABLE 1.—ARSENICAL SPRAY APPLICATIONS ADVISED IN 1926

Period	Materials	Insects present	Dates of application by counties							
			Berks	Bucks	Chester	Delaware	Lebanon	Lehigh	Montgomery	Philadelphia
Delayed Dormant	Lime sulfur diluted to 1.03 Sp. gr. Lead arsenate 3 lbs. per 100 gals. Nicotine 1 pint per 100 gals.	Apple aphids Early worms Scale Tent caterpillars	April 21	April 22	April 19	April 19	April 21	April 23	April 19	April 19
Pre-Blossom	Lime sulfur diluted to 1.008 Sp. gr. Lead arsenate 3 lbs. per 100 gals. Nicotine 1 pint per 100 gals.	Apple scab Bud moths Leaf-rollers Apple aphids	May 6	May 5	May 4	May 3	May 6	May 7	May 4	May 3
Petal Fall or Calyx	Same as pre-blossom	Apple aphids Red bugs Codling moth Curuclio Apple scab	May 17	May 17	May 16	May 14	May 17	May 19	May 16	May 14
Emergency	Lime sulfur diluted to 1.008 Sp. gr. Lead arsenate 3 lbs. per 100 gals.	Apple scab Curculio Codling moth	May 27	June 1	May 27	May 27	May 28	June 8	May 27	May 28
Cluster Apple	Spreader Same as emergency	Apple scab Curculio Codling moth Leaf-rollers	June 16	June 8	June 8	June 8	June 15	June 17	June 8	June 8
Summer	Lime sulfur and Lead arsenate as in emergency	Codling moth Leaf-rollers	July 30	July 18	July 16	July 16	July 17	July 19	July 16	July 16

receive the emergency application. As a result, in this orchard there was an increased amount of curculio injuries. Orchard 18 was used to determine the intensity of insect injuries. The figures, Table 2, indicate the efficiency of the advised spraying practices.

TABLE 2.—RESULTS OF COMMERCIAL SPRAYING FOR FRUIT PROTECTION
Classification of Injuries†

Orchard No.	Treatment*	Plum Curculio Per cent	Fruit Worms Per cent	Codling Moth Per cent	Injured Fruit Per cent	Clean Fruit Per cent
1	As advised	1	0	0	1	99
2	As advised	0	2	2	4	96
3	Sprayed Personally	5	0	2	7	93
4	As advised	2	6	0	8	92
5	As advised	6	4	2	12	88
6	As advised	7	5	3	15	85
7	As advised	11	4	2	17	83
8	As advised	13	4	0	17	83
9	As advised	8	6	4	18	82
10	As advised	10	5	3	18	82
11	As advised	8	7	5	20	80
12	As advised	14	0	6	20	80
13	As advised	15	1	4	20	80
14	As advised	10	2	12	24	76
15	As advised	16	5	5	26	74
16	Last application a dust	14	4	11	29	71
17	Emergency application not used	15	12	6	33	67
18	Three applications at random	20	13	19	52	48

*"As advised" means that the orchard was treated according to the recommendations of the spraying service.

†The classification "Fruit Worms" is used to include all injuries caused by species such as green fruit worms, bud moths, and leaf-rollers.

The data expressed in Table 2 were obtained from 18 different orchards located in six different counties of southeastern Pennsylvania. In general, the results indicate that the number of arsenical treatments suggested were sufficient to protect the fruit. It is also evident that any diminution in the numbers of treatments could not have been expected to afford adequate fruit protection.

Arsenic Content of the Spray Residues

Methods of Sampling

Samples consisting of 24 apples each, were selected in the orchards represented in Table 2 and in other plantings. A total of 33 orchards in 17 counties contributed samples for analyses. In picking the fruits those which had the heaviest spray deposit were secured. A square of heavy paper was placed around each apple and the fruit carefully removed from the branch. Each sample was packed in a cardboard carton and sent to the laboratory. All fruits were collected from the lower branches, where the maximum amounts of visible residue were found on the fruit before it was handled. A second collection was made from the same orchards, taking fruits from containers ready for market.

Methods of Analysis

The different samples used were weighed before treatment for the removal of arsenic, and the AS_2O_3 calculated per pound of fruit.

The modified Gutzeit method[2] was used and gave satisfactory results. In removing the total quantity of arsenic from the surface of the apples it was found that a 7 per cent ammonium hydroxide solution gave approximately as satisfactory results as were obtained by the use of a mixture of hot concentrated nitric and sulfuric acid. In either case, care was taken to remove any residue from the stem, cavity and calyx of each apple, and the surface was thoroughly washed with water. The solution obtained was then made up to volume and an aliquot was taken for analysis.

All determinations were made under the same conditions as to length of time, temperature, acidity, amount and surface area of the zinc employed. The results obtained are given in Table 3.

The amount of rain fall is known[3] to have a direct influence on the amount of arsenic found in spray residues and should be considered in connection with the analysis. The samples analyzed were exposed to rains which are indicated in the graph, Table 4. During the months of April, May, June and July there was a total deficiency in rainfall of 4.73 inches, but there was an excess of 5.12 inches through August, September and October.[4] Since but three of the samples analyzed were sprayed after July 31, the majority of the fruits were subjected to rains in excess of the normal precipitation.

[2]Scott, W. W., 1917, Standard Methods of Chemical Analysis. P. 40. New York City.

[3]O'Kane, W. C., Hadley, C. H., and Osgood, W. A., Bulletin No. 183, N. H. Agricultural Experiment Station.

[4]U. S. Weather Bureau, Philadelphia, Pa., 1926.

TABLE 3.—RESULTS OF ARSENICAL ANALYSES

Sample No.	Location County	No. Ars. sprays	Date last application	Amount spray residue	Date collected	Amount AS_2O_3 per lb. apples Grains
1	Montgomery	3	July 16	Light to medium	Oct. 6	0.0019
2	Montgomery	3†	July 16	Heavy	Oct. 6	0.0026
3	Bucks	2	June 1	Light	Oct. 7	0.0003
4	Bucks	3	July 18	Light	Oct. 7	0.0010
5	Lehigh	2 & 1 dust*	July 19	Light	Oct. 8	0.0004
6	Lehigh	3	July 19	Heavy	Oct. 8	0.0013
7	Philadelphia	3	July 16	Heavy	Oct. 12	0.0018
8	Philadelphia	3	July 16	Heavy	Oct. 12	0.0014
9	Berks	3	July 30	Heavy	Oct. 14	0.0004
10	Berks	3	July 30	Heavy	Oct. 14	0.0004
11	Delaware	2 & 1 dust*	Aug. 6	Very light	Oct. 19	Trace
12	Delaware	2 & 1 dust*	July 15	Medium	Oct. 19	0.0004
13	Lebanon	3	July 17	Light	Nov. 4	0.0004
14	Lebanon	3	July 17	Light	Nov. 4	0.0020
15	Adams	4 dusts	June 30	None	Oct. 8	Trace
16	Adams	3 sprays	July 1	Light	Oct. 8	0.0002
17	Adams	4	July 23	Heavy	Oct. 8	0.0009
18	Franklin	2	July 2	Medium	Oct. 9	Trace
19	Franklin	4	July 20	Heavy	Oct. 9	0.0007
20	Franklin	4	July 26	Heavy	Oct. 9	0.0013
21	Franklin	4 & 1 dust*	Aug. 1	Light	Oct. 9	0.0005
22	Lycoming	3	July 31	Heavy	Oct. 12	0.0007
23	Lycoming	3	July 31	Medium	Oct. 12	0.0004
24	Lycoming	3	July 31	Heavy	Oct. 12	0.0005
25	Lycoming	4	Aug. 2	Very heavy	Oct. 12	0.0059
26	Lycoming	4	Aug. 2	Very heavy	Oct. 12	0.0057
27	Lycoming	4	Aug. 2	Very heavy	Oct. 12	0.0059
28	Lycoming	4	Aug. 2	Very heavy	Oct. 12	0.0041
29	Carbon	3	July 1	Very light	Oct. 14	0.0008
30	Carbon	3	June 11	Very light	Oct. 14	Trace
31	Carbon	3	July 7	Very light	Oct. 14	0.0005
32	Schuylkill	3	July 10	None	Oct. 15	0.0005
33	Schuylkill	4	July 15	Light	Oct. 15	0.0010
34	Mifflin	4	July 26	Light	Oct. 22	0.0005
35	Mifflin	4	July 26	Medium	Oct. 22	0.0007
36	Mifflin	4	July 26	Heavy	Oct. 22	0.0017
37	Juniata	3	July 3	Medium	Oct. 22	0.0007
38	Lawrence	3	Aug. 5	Medium	Oct. 23	0.0012
39	Lawrence	3	Aug. 5	Medium	Oct. 23	0.0010
40	Washington	3†	Aug. 1	Light	Oct. 23	0.0004
41	Washington	3	Aug. 1	Light to Medium	Oct. 23	0.0035
42	Fayette	3	Aug. 1	Medium	Oct. 22	0.0019

*Last application.

†Colloidal lead arsenate.

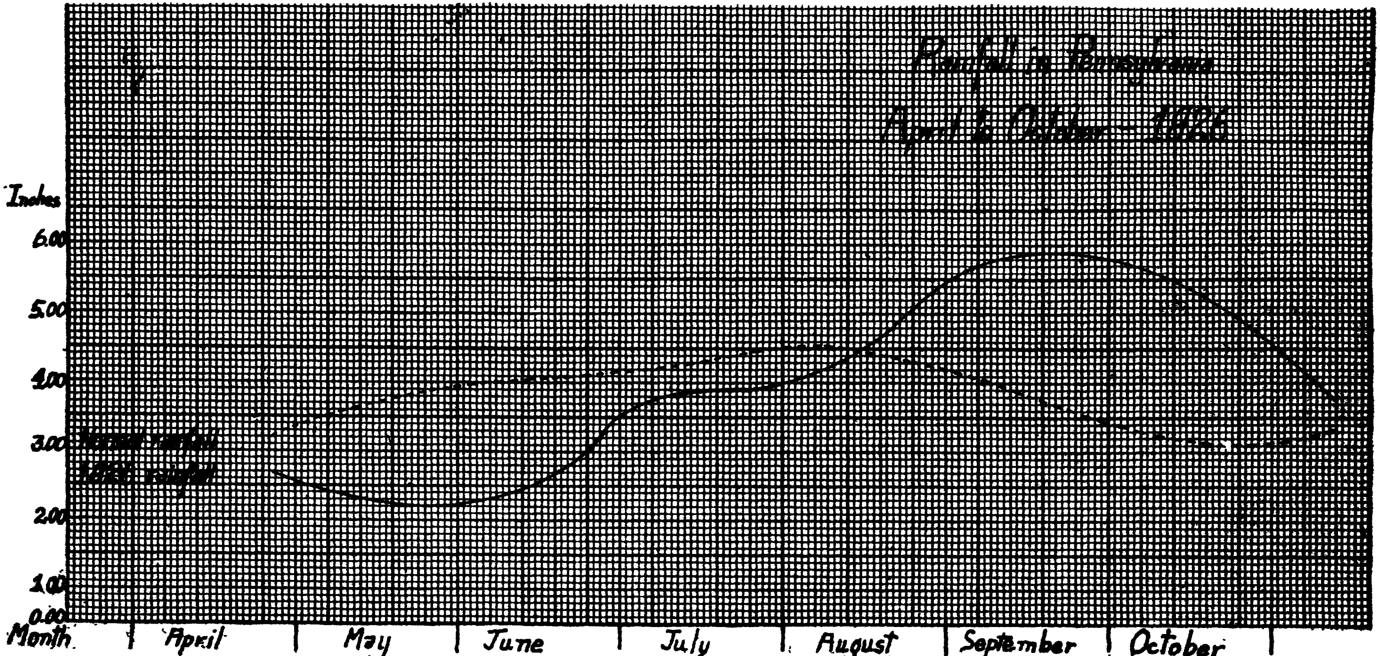

FIG. 23.—Graph showing rainfall in Pennsylvania

The analytical findings seem to justify certain conclusions. Arsenic, with but one exception, was found on all samples tested. In no case was there found an amount of arsenic equivalent to 1/100 of a grain per pound of apples, the stated British tolerance. These results, however, were all made previous to any handling of the fruit. When the apples were presented for public consumption the amount of arsenic found was reduced to a trace, (see Table 5).

It was found that the relative quantity of visible spray residue did not serve as an index of the *quantity* of arsenic present. As a matter of fact, as much arsenic was found on apples having no visible spray residue, as on those having considerable residual material on their surface.

Different samples obtained from the same orchard and receiving the same treatment showed a uniform quantity of arsenic present.

TABLE 5.—AMOUNTS OF ARSENIC ON FRUITS BEFORE AND AFTER HANDLING

Sample	Amount of visible spray residue		Amount of arsenic (AS_2O_3)	
No.	Before handling	After handling	Before handling	After handling
			Grains per pound	
1	Light	None	0.0019	Trace
2	Heavy	Very light	0.0026	Trace
3	Light	None	0.0003	Trace
4	Light	None	0.0010	Trace
5	Heavy	None	0.0004	Trace
6	Heavy	None	0.0004	Trace
7	Light	None	0.0004	Trace
8	Light	None	0.0020	Trace
9	Light	None	Trace	Trace
10	Light	None	0.0004	Trace

SUMMARY

Under conditions prevailing in Pennsylvania during 1926, it was found commercially feasible to produce marketable apples without objectionable spray residues. Sprays were applied with but little, if any, deviation from the usual procedure and no supplementary preparation of the fruit was necessary.

Visibility of spray deposits on these apples was no indication of the relative quantities of the poison.

The authors recognize that there were imperfections of methods in sampling and analysis, unusual climatological conditions, and that the study was of comparatively short duration. The results are presented, however, as a regional contribution to a subject of national interest.

REDUCING THE COST OF NICOTINE SULPHATE SPRAYS

By H. N. WORTHLEY, *Assistant Professor of Entomology Extension, Pennsylvania State College*[1]

ABSTRACT

A reduction in the cost of nicotine sprays is sought by the use of "liberators." In this connection the efficiency of some common chemicals is recorded and data presented suggesting that their use in nicotine sulphate sprays will allow a reduction in dosage of nicotine.

INTRODUCTION

It has been known for many years that decoctions of tobacco in water possess insecticidal properties. Bourcart,[2] in discussing tobacco (pp. 371–375), makes mention of the tobacco juices sold by the French government, and differentiates between "new juice" and "old juices." The former contains up to 10 per cent of nicotine, while the latter contain only about one-fifth as much. He also gives the formulas recommended by several European investigators for the home preparation of spray solutions from these juices.

In the United States, solutions of nicotine sulphate $(C_{10}H_{14}N_2)_2.(H_2SO_4)$ guaranteed to contain not less than 40 per cent of nicotine have been placed on the market in recent years, and are now the standard form for the out-of-doors application of nicotine. Nicotine sulphate is a stable salt and does not deteriorate in the package. In consequence, dosage requirements do not have to be figured for each lot, as with the French tobacco juices. This is an obvious practical advantage in favor of the stable product. This advantage, however, has an attendant disadvantage. Solutions of nicotine sulphate when sprayed upon the foliage of plants do not give up their nicotine to the atmosphere as freely as do solutions of uncombined nicotine. The importance of this fact is now recognized, for McIndoo[3] has shown that the action of nicotine as an insecticide is due largely to the fumes, which enter the tracheae of insects and exert a paralyzing action on the nervous system.

With this in mind, Headlee and Rudolfs,[4] and De Ong[5] have demon-

[1]Contribution from the Department of Entomology, Massachusetts Agricultural Experiment Station. A report of progress in a study interrupted by the resignation of the writer on March 1, 1925.

[2]Bourcart, E. Insecticides, Fungicides and Weed Killers. Scott, Greenwood and Son. 1913.

[3]McIndoo, N. Effects of Nicotine as an Insecticide. Jour. Agr. Res., V. 7, pp. 89–122, 1916.

[4]Headlee, T. J., and Rudolfs, W. Some Principles which Underlie the Making and Use of Nicotine Dust. N. J. Agr. Exp. Sta. Bull. 381, Jan., 1923.

[5]De Ong, E. R. The Relation Between the Volatility and Toxicity of Nicotine in Sprays and Dusts. Jour. Econ. Ent., V. 16, No. 6, pp. 486–493, Dec., 1923.

strated that the killing efficiency of nicotine in dust and spray mixtures against aphids varies directly with the rate at which gaseous nicotine is evolved. De Ong, working with a pure nicotine sulphate of his own manufacture, showed that certain alkalis, by combining with the sulphuric acid, hasten the evolution of gaseous nicotine from spray mixtures of nicotine sulphate.

The Problem

"To reduce the ultimate cost to the consumer we must do one of two things—reduce the cost of raw materials—or attain the same result by making the same materials of the same cost more effective, go farther, or have greater lasting effect. Chief among the materials which are objected to because of their cost are arsenic and nicotine."[6]

Failing a reduction in the cost of manufacture of nicotine, the grower, by the use of alkalis, should be able to increase the efficiency of his nicotine sulphate sprays. The question naturally arises, "If nicotine sulphate at a given dilution is 100 per cent effective, should not the addition of an alkali by increasing the rate of evolution of nicotine allow a reduction in the dosage?

Quantitative Studies of Nicotine Evolution

In order to discover the respective merits of a number of common chemicals as liberators of nicotine from spray solutions of nicotine sulphate, a series of tests was run, in which 10 c. c. samples of different spray mixtures were exposed in drops on glass plates in a room kept at a constant temperature. At definite intervals of time, the residues were carefully washed from the plates with very dilute hydrochloric acid and anlayzed for nicotine by the Chapin method,[7] using his alternative method (ibid; p. 13) of weighing the anhydrous salt. By this procedure a curve could be plotted for each liberator investigated, showing the per cent of nicotine evolved after different intervals of time.[8] This is the method followed by De Ong.[5]

A list of the chemicals tried as liberators, with the amounts of each necessary to exactly neutralize 1 c.c. of Black-leaf "40," follows:—

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[6]Dickerson, J. K. Some Chemical Problems of the Insecticide Industry. Jour. Ind. and Eng. Chem., V. 16, No. 10, pp. 1013–1015, Oct., 1924.

[7]Chapin, R. M. The Determination of Nicotine in Nicotine Solutions and Tobacco Extract. U. S. D. A., Bur. An. Ind. Bull. 133, Apr., 1911.

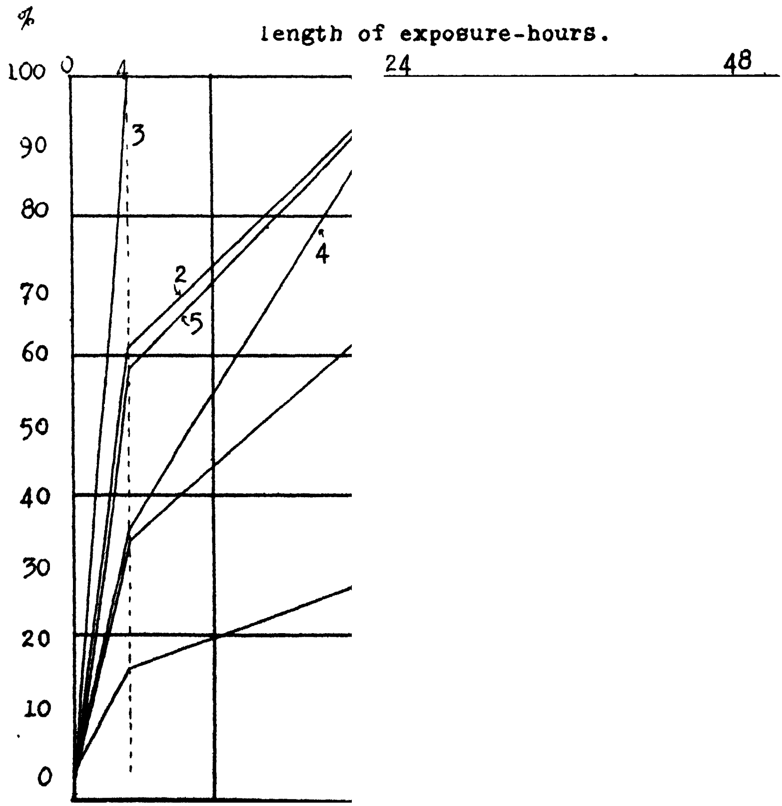
[8]Acknowledgment is gratefully made of the kindness of the Departments of Chemistry and Microbiology, of the Massachusetts Agricultural College. Equipment for the work was willingly placed at the writer's disposal, and the members of these departments unfailingly gratified the frequent desire of the writer to discuss the work.

TABLE 1.—ALKALINITY OF LIBERATORS

Liberator	Amount to neutralize 1 c.c. Black-leaf "40" Indicator brom-thymol-blue Checked by potentiometer
Ammonia	.4 c.c.
Ammonium carbonate	.4 gm.
Sal soda (Arm & Hammer Brand—Crystals)	.34 gm.
Sodium hydroxide	.08 gm.
Gold Dust washing powder	.36 gm.
Ivory Soap flakes	.6 gm.
Good's Caustic Potash Fish-oil soap	1.1 c.c.

The solutions for the gas evolution tests were made up at a strength of 1 part Black-leaf "40" to 100 parts of CO_2 free distilled water, using twice the amount of each liberator necessary to exactly neutralize the

CHART I. EVOLUTION OF NICOTINE FROM SPRAY SOLUTIONS OF BLACK-LEAF "40", 1-100.



Black-leaf "40" present. In addition, the pH of each solution was determined.

In this series of tests, determinations of nicotine were made by washing the exposed plates after 4 hours, 24 hours, and 48 hours. In Table 2, the liberators selected are shown in comparison with a solution of Black-leaf "40" alone, and with sodium hydroxide, which appeared to be the most efficient liberator mentioned by De Ong.[5] Chart I is a graphic representation of the data.

TABLE 2.—EVOLUTION OF NICOTINE FROM SPRAY SOLUTIONS OF BLACK-LEAF "40," 1:100

No.	Liberator Used	Per cent Nicotine Evolved in 4 hours	24 Hours	48 Hours	pH of Solution
1	None	15	30	35	3.25
2	Sal soda	61	100		9.17
3	*Sal Soda	100			9.5
4	Sodium hydroxide	35	100		11.75
5	*Sodium hydroxide	58	100		12.17
6	Potash fish-oil soap	34	69	77	7.35

*Liberator at twice the strength of the preceding solution.

The following facts are evident from the above table:

1. The greatest alkalinity is not attended by the greatest evolution of nicotine.

2. Sal soda, while giving a lower alkalinity to the spray solution, is a more efficient liberator than sodium hydroxide.

3. Potash fish-oil soap added to the spray solution causes a slower evolution of nicotine over a longer period of time than from a solution to which sal soda has been added. The rate of evolution, however, is considerably greater than from solutions of Black-leaf "40" alone.

Sal soda and caustic potash fish-oil soap were selected for further study for the following reasons:

1. Among the chemicals tried, sal soda appeared to be the most efficient "liberator" (i. e., throws off the nicotine most rapidly).

2. Under certain conditions it may be more desirable to liberate the nicotine slowly over a longer period of time. Potash fish-oil soap serves this purpose, is a pourable soap mixing readily with water, and gives a beneficial physical character to the spray solution.

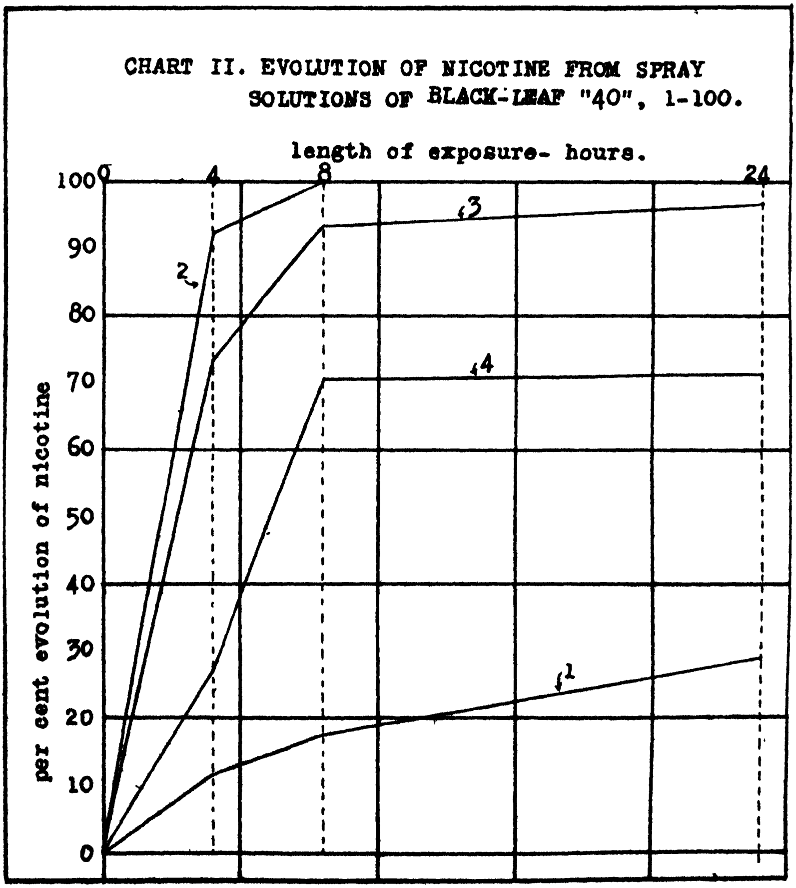
3. Both materials are cheap and readily available to the farmer.

In the subsequent study, solutions of Black-leaf "40" at 1–100 were used, and sal soda at twice the strength necessary to neutralize the Black-leaf "40" present was compared with Bordeaux mixture 4–4–50, and lime sulphur 1–40. These last two materials are alkaline in nature, and are much used in combination sprays with nicotine.

These tests were run in the same room as before, but the temperature was not automatically controlled. It fluctuated between 83°F. and 86.7°F., as recorded by a thermograph. A record of the relative humidity was also obtained. This was very low, and fluctuated between 12 per cent and 26 per cent saturation. A record of this experiment is given in Table 3 and Chart II.

TABLE 3.—EVOLUTION OF NICOTINE FROM SPRAY SOLUTIONS OF BLACK-LEAF "40," 1–100

No.	Liberator used	Per cent Nicotine Evolved in 4 Hours	8 Hours	24 Hours
1	None	11.47	17.42	28.78
2.	Sal soda	92.13	100.00	100.00
3.	Bordeaux mixture	73.09	93.50	96.75
4.	Lime sulphur	26.68	70.67	70.84



The following points are to be noted:—

1. The use of Bordeaux mixture and lime-sulphur as carriers of nicotine sulphate in spray solutions, under the conditions of the experiment, caused a rapid evolution of nicotine. While this rate was not quite as rapid as in the case of sal soda, it is quite likely that under field conditions this difference would be less marked.

2. In the case of lime-sulphur, a fairly rapid rate of evolution resulted in a loss of 70.6 per cent of the nicotine in eight hours. After twenty-four hours, only a fraction of 1 per cent additional nicotine had been liberated. Thus nearly 30 per cent of the total nicotine appeared to be bound by the lime-sulphur.

Tests Against Insects

In the spraying tests, twigs laden with aphids were sprayed, using a hand atomizer, and confined, either in cheesecloth covered cages, or on sheets of paper with tanglefooted edges. Counts of the living and dead aphids were made after twenty-four hours, and, in some cases, after shorter and longer periods of time. The percentage killed in each case was figured. Eighty-nine separate sprayings were made during the season of 1924, involving a total of 23,045 aphids. These tests cannot be called extensive, but the results are indicative.

Each experiment called for one twig sprayed with Black-leaf "40" without liberator, one with Black-leaf "40" plus sal soda, and one with Black-leaf "40" plus the potash fish-oil soap. The liberators were employed at twice the amount necessary to neutralize the Black-leaf "40" present. In a few cases the merits of Pyrox and of liquid lime-sulphur were also tested. The species involved were *Myzus persicae*, *Aphis pomi*, and an undetermined species of aphis on spiraea. A summary of results is given in Table 4.

Table 4.—Nicotine Sulphate Versus Aphids. Average—All Tests

% Kill After 24 Hours

No Liberator	Plus Soda	Plus Soap
78	94	95

With the figures on the evolution of nicotine in mind, the high per cent kill afforded by the use of caustic potash fish-oil soap as a liberator indicates a slight insecticidal action of the soap itself or possibly of liberated fish-oil, even at the reduced dosage used (less than one-fifth the amount recommended by James Good & Company, for aphids).

A comparison between the effectiveness of sal soda as a liberator, and Pyrox and liquid lime-sulphur is given in Table 5.

Pyrox, a ready-made Bordeaux-lead, and liquid lime-sulphur, with

TABLE 5.—BLACK-LEAF "40," 1–1000, AGAINST AN APHID ON BARBERRY

No.	Liberator	% Kill After 6 Hours	% Kill After 24 Hours
1.	None	20	73
2.	Sal soda	52	97
3.	Pyrox	38	93
4.	Soda+Pyrox	58	93
5.	Lime-sulphur (1–40)	39	88
6.	Soda+Lime-sulphur	63	97

CHART III. BLACK-LEAF "40" PLUS LIBERATORS AGAINST *Myzus persicae*

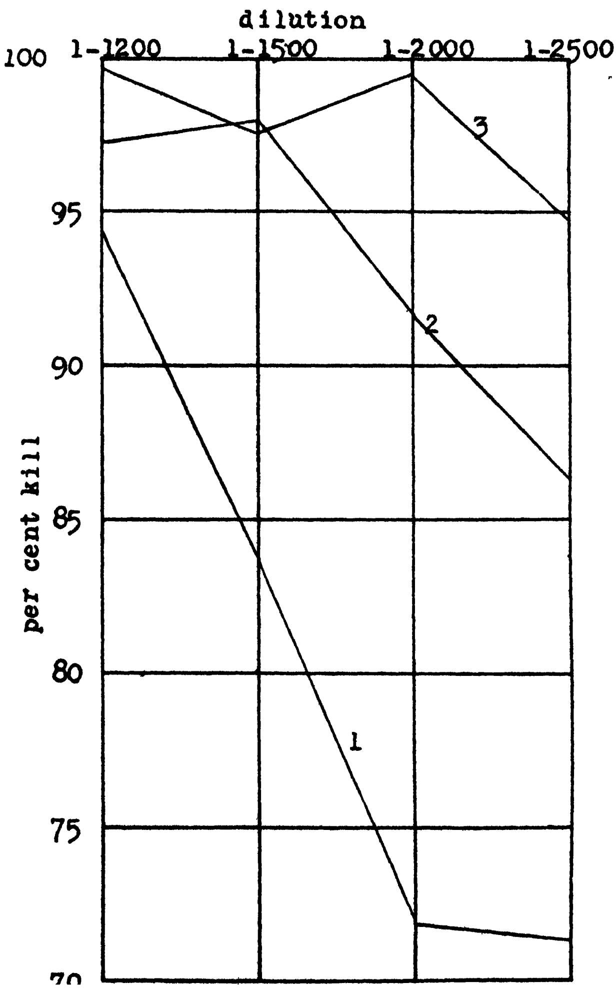
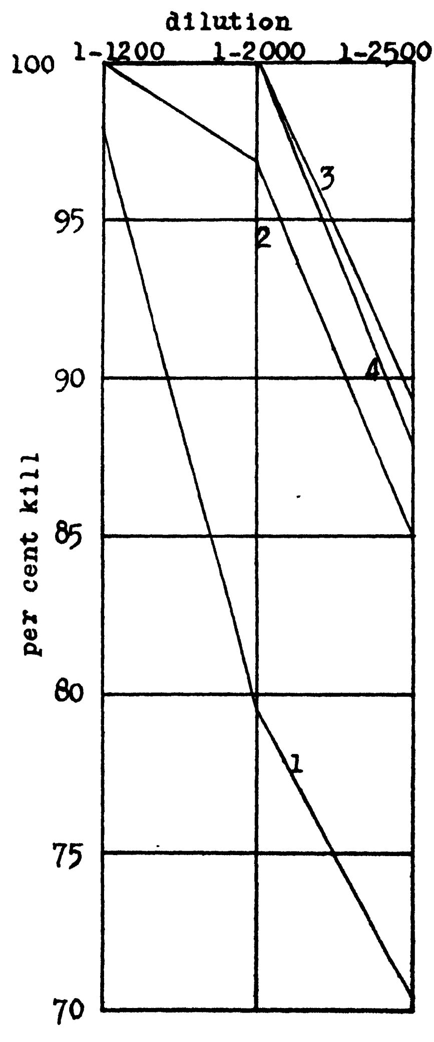


CHART IV. BLACK-LEAF "40" PLUS LIBERATORS AGAINST *Aphis pomi*



which Black-leaf "40" is often combined for spraying purposes, are themselves alkaline, and so increase the rate of evolution of the nicotine. This is indicated by the experiment. It further appears that the addition of sal soda to these combination sprays increases the rate and total per cent of kill. The effect of the sal soda on the effectiveness of the

nicotine-lime-sulphur combination was less marked in the experiments on *Aphis pomi*, as will be shown.

Reduction of Dosage Through Use of Liberators

It is logical to suppose that, if liberators increase the killing power of a solution of nicotine sulphate of given strength, the use of liberators will allow a reduction in dosage of nicotine. To gain information on this point, a series of nicotine sprays was applied at various dilutions. The results are given in Tables 6 and 7, and Charts III and IV.

Table 6.—Black-Leaf "40" Plus Liberators Against *Myzus persicae*

No.	Liberator	% Killed at Dilution of			
		1–1200	1–1500	1–2000	1–2500
1.	None	94.3	83.5	71.9	71.4
2.	Sal soda	97.3	98.0	91.6	86.4
3.	Fish-oil soap	99.7	97.6	99.5	94.7

Table 7.—Black-Leaf "40" Plus Liberators Against *Aphis pomi*

No.	Liberator	% Killed at Dilution of		
		1–1200	1–2000	1–2500
1.	None	98	79.5	70.5
2.	Lime-Sulphur Lead Arsenate	100	96.9	85.0
3.	As in No. 2 plus sal soda	100	100	89.3
4.	Fish-oil soap	100	100	87.9

That the use of liberators will allow a reduction of dosage is plainly indicated. Thus in Graph No. 1, Black-leaf "40" at a dilution of 1–2500 plus potash fish-oil soap gave 95 per cent control, while a dilution of 1–1200 with no liberator gave only 94 per cent control. In Graph No. 2, Black-leaf "40" alone at 1–1200 is little better than Black-leaf "40" 1–2000 plus lime-sulphur, and the addition of sal soda to the regular orchard combination spray appears to make nicotine sulphate perfectly effective against *Aphis pomi* at 1-2000. The possibility of detrimental chemical reactions between the sal soda, the lead arsenate, and the lime-sulphur have not been investigated by the writer. At the rate used in these tests, a 100 gallon tank of Black-leaf "40", 1–1000, requires eight ounces of sal soda, or a pint and a half of potash fish-oil soap.

Application to Squash Vine Borer Control

Further information regarding dosage reduction was obtained in 1924, from field trials of nicotine in dust and spray forms against eggs of the squash vine borer. The writer[9] has shown that Black-leaf "40" at a

[9]Worthley, H. N. The Control of the Squash Vine Borer in Massachusetts. Mass. Agr. Exp. Sta. Bul. 218, Oct., 1923.

dilution of 1 to 200 is effective in this connection. A reduction of dosage requirement was sought. Without going into detail, that portion of the work which is of present interest is here summarized.

NICOTINE AGAINST *Melittia satyriniformis* HBN., AMHERST, MASS., 1924

Treatment	I B. L. "40," 1–250 Alone				III B. L. "40," 1–500 +Soda				IV B. L. "40," 1–500 +Soap			
		Check		Check		Check		Check		Check		Check
Row	2	1	9	10	5	4	12	13	8	7	15	16
No. plants	32	33	45	27	35	29	34	39	38	32	36	34
Plants infested	8	22	17	25	28	25	22	26	18	27	15	32
Per cent infested	25	66	37	92	80	86	64	66	47	84	41	94
No. borers	15	44	25	63	49	66	61	47	25	87	19	93
Borers per plant	.46	1.33	.55	2.33	1.40	2.27	1.79	1.20	.65	2.71	.52	2.73
Per cent infestation treated / check	34		23		61		149		23		19	
Average Per cent infestation		28				105				21		

Translating the average per cent of infestation to per cent of control, we have:

I. Black-leaf "40", 1–250, alone . . . . 73% ± 8% control*
III. Black-leaf "40", 1–500, plus sal soda. . . . . No control
IV. Black-leaf "40", 1–500, plus fish-oil osap. 80% ± 8% control*

The failure of sal soda is attributed to the speed with which the nicotine was thrown off, evidently dissipating it before any could penetrate into the eggs. The striking results with the fish-oil soap, while partly due to the increased evolution of nicotine, are doubtless directly affected by the physical nature of the film of spray which spread, stuck, and dried over the eggs, thus aiding the penetration of the nicotine. A mixture of Black-leaf "40", 1½ pints; potash fish-oil soap, 3 pints; water, 100 gallons, will reduce an infestation of the squash vine borer approximately 80 per cent, using 4 sprays, a week apart in July.

*Probable error figured from the field data.

Conclusion

The work reported in this paper indicates that the use of liberators may allow a reduction in the dosage of nicotine required to kill certain insects. This is accomplished by the increased concentration of nicotine in the atmosphere surrounding the insects occasioned by the more rapid evolution of the nicotine fumes.

Bordeaux mixture and lime-sulphur are good liberators of nicotine, but the efficiency of nicotine in such sprays is increased by the addition of sal soda. With forms easily controlled this may allow a reduction in dosage. It may also aid in reducing such stubborn pests as the rosy apple aphis in curled leaves, and the apple red bugs.

Potash fish-oil soap seems to be the most satisfactory liberator of nicotine when this is used alone, and particularly against resistant forms, such as insect eggs.

For every pint of nicotine sulphate, 12 ounces of sal soda or a quart of fish-oil soap added to the spray mixture will act effectively to increase the efficiency of the nicotine. Potash fish-oil soap gives relatively slow, long continued evolution of nicotine, while sal soda throws it out into the air with great rapidity. As shown in the tests against squash vine borer eggs, this extremely swift evolution of nicotine is not always desirable.

CHEMICAL STUDIES OF THE SULFUR-LIME DRY MIX SPRAY IN REGARD TO THE FORMATION OF WATER SOLUBLE ARSENIC[1]

By Joseph M. Ginsburg, *Biochemist in Entomology, New Jersey Agricultural Experiment Station*

Abstract

When Kayso is mixed with acid lead arsenate in absence of both hydrated lime and sulfur, large quantities of soluble arsenic are formed. Still larger quantities of soluble arsenic are released when Kayso is replaced by calcium carbonate. When powdered skimmed milk was substituted for Kayso, a decided reduction in soluble arsenic was found, while no decrease in spreading was observed. The addition of an excess of hydrated lime to the arsenical mixture greatly decreased the amount of soluble arsenic formed but did not entirely eliminate it. Sulfur alone, in absence of Kayso and calcium hydroxide, did not materially influence the decomposition of acid lead arsenate.

Paper No. 314 of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

Introduction

Among the several arsenic compounds that have been used as insecticides, the acid lead arsenate ($PbHAsO_4$) remains the outstanding one and is more extensively employed now in orchard sprays than any one of the other arsenicals. Recent investigations have definitely established that this compound, if properly prepared, (13) is comparatively stable and is more toxic to insects (10, 18) than the arsenates of calcium or the basic lead arsenate. Judging from its efficiency as an insecticide and its popularity among agriculturists, it is not an exaggeration to say that this arsenical is, at present, our very best poison for chewing insects which feed on fruit trees, yet it is far from being the ideal one sought for. While it is only slightly soluble in distilled water, chlorides, carbonates, (5, 7) and soluble bases (2), when present in such quantities as may be frequently found in spring or in well waters, are sufficient to decompose it and to liberate arsenic acid or soluble arsenic salts, often in sufficient quantities to cause foliage injury.

It must be recalled here that lead is a weak base and any one of the stronger bases, such as potassium, sodium, or even calcium, when present in soluble form, will readily replace it and combine with the arsenate radical to form soluble salts. Hence $PbHAsO_4$ cannot safely be used in spray mixtures containing soluble soaps (14) or oils emulsified by the aid of soaps.

Furthermore, acid lead arsenate cannot be applied alone on fruit trees in concentrations sufficient to kill insects, without causing injury to foliage, unless some "corrective" such as lime is added. Evidently the $PbHAsO_4$ decomposes when spread on the leaf surface, a process in which the leaf exudates (15) may play an important role, especially if rich in alkalies (16). Lime has been universally used as a corrective since its introduction by Gillette (4) both in dust and liquid mixtures. Hydrated lime is, at present, being used in the sulfur lime dry-mix spray (3) which consists of eight pounds of sulfur, four pounds of hydrated lime, half a pound of Kayso (casein+lime) diluted to fifty gallons of water to which one or 1½ pounds of powered lead arsenate is added. This mixture offers an ideal spray since it serves as a combined insecticide and fungicide and is easily handled. Frequently, however, appreciable burning occurs on peach and apple trees, especially the former, when this spray is used. Haenseler and Martin (6) at this Station have definitely traced the cause of the injury to the lead arsenate.

That arsenical injury to foliage may be, with certainty, ascribed to the water soluble arsenic originally present in the spray or subsequently

formed on the leaf surface has been definitely shown (1, 9, 16, 17) by several investigators. Results from more recent experiments (5, 11) indicate that the calcium carbonate formed when the $Ca(OH)_2$ is exposed to the atmosphere releases water soluble arsenic. The exact chemical role, however, that each one of the three ingredients present in this spray plays in the process of decomposing the lead arsenate has not been definitely established. It is obvious that a better understanding of the reactions involved should offer a means of detecting and possibly of controlling the factors which liberate water soluble arsenic in this spray mixture.

The following investigation was, therefore, carried out with the purpose of studying the influence of each one of the three ingredients namely, hydrated lime, sulfur, and Kayso on the formation of water soluble arsenic from the acid lead arsenate in the sulfur, lime, dry-mix spray.

Experimental

Samples of lead arsenate were mixed with weighed quantities of hydrated lime, sulfur, and Kayso separately; hydrated lime and sulfur; hydrated lime and Kayso; sulfur and Kayso; and finally with all the three ingredients in proportions corresponding to the complete spray. These combinations gave eight different mixtures, including lead arsenate alone used as check. The materials were weighed separately into glass bottles, thoroughly mixed, and 100 c.c. distilled water, previously freed from CO_2, added. The mixtures were kept at room temperature for six days, with frequent shaking, and then diluted to 500 c.c. with distilled water and allowed to stand over night. At the end of this period water soluble arsenic was determined by the Official Methods (12) and calculated as As_2O_5, the percentages being based only on the amount of $PbHAsO_4$ present in the mixtures. The quantities of the different ingredients were equal to those present in 100 c.c. of spray when 1½ pounds of lead-arsenate are used.

A comparison of the data from the chemical analyses shows that hydrated lime reduced the per cent of water soluble arsenic from 2.63 found in the check to 0.91 when added alone to the lead-arsenate and to 0.58 when added mixed with sulfur. On the other hand, the presence of "Kayso" released more than twice the amount of soluble As_2O_5(6.79%) found in the check. Similar increases in soluble arsenic were also observed in mixture 7, where both "Kayso" and sulfur were added. Sulfur in itself, however, has not appreciably affected the decomposition of PbH-AsO_4 as may be seen from mixture No.3. The fact that Kayso liberated large quantities of soluble As_2O_5 was rather surprising at first, but upon

TABLE 1.—WATER SOLUBLE ARSENIC OBTAINED FROM ACID LEAD ARSENATE WHEN MIXED WITH HYDRATED LIME, KAYSO, AND SULFUR AND KEPT FOR SIX DAYS AT ROOM TEMPERATURE

Mixture No.	Composition	As_2O_5% Series 1	As_2O_5% Series 2	As_2O_5% Average
1 (Check)	$PbHAsO_4$	2.45	2.80	2.63
2	$PbHAsO_4$, $Ca(OH)_2$	0.74	1.07	0.91
3	$PbHAsO_4$, Sulfur	2.67	2.88	2.72
4	$PbHAsO_4$, Kayso	6.43	7.15	6.79
5	$PbHAsO_4$, $Ca(OH)_2$, Sulfur	0.49	0.66	0.58
6	$PbHAsO_4$, $Ca(OH)_2$, Kayso	0.91	0.83	0.87
7	$PbHAsO_4$, Sulfur, Kayso	6.67	8.25	7.46
8	$PbHAsO_4$, $Ca(OH)_2$, Sulfur, Kayso (Complete Sulfur-lime dry-mix Spray)	0.57	0.78	0.67

further testing it was found to contain considerable quantities of calcium carbonate. It was, therefore, suspected that the $CaCO_3$ was responsible for the above reaction. This assumption was beautifully confirmed by the following experiment, the results of which are presented in Table 2. Several 100 c.c. mixtures were prepared and submitted to the same treatment as described above, with the exception that Kayso was replaced by equal amounts of one of the following:—calcium carbonate, powdered skimmed milk, or casein.

TABLE 2.—WATER SOLUBLE ARSENIC OBTAINED FROM ACID LEAD ARSENATE MIXED WITH CALCIUM CARBONATE, SKIM MILK, CASEIN AND KEPT FOR SIX DAYS AT ROOM TEMPERATURE

Mixture No.	Composition	As_2O_5% 1	As_2O_5% 1	As_2O_5% Average
9 (Check)	$PbHAsO_4$	2.12	2.29	2.20
10	$PbHAsO_4$, $CaCO_3$, Sulfur	7.17	9.32	8.25
11	$PbHAsO_4$, Skim Milk	1.20	1.05	1.13
12	$PbHAsO_4$, Casein	1.20	1.11	1.16
13	$PbHAsO_4$, Sulfur, Skim Milk	1.20	1.32	1.26
14	$PbHAsO_4$, Sulfur, Casein	1.27	1.27	1.27

The per cent of water soluble arsenic from mixture 10, where $CaCO_3$ was used was still greater than that obtained in the presence of Kayso (mixture 4 and 7). On the other hand, wherever Kayso was replaced by either powdered skimmed milk or casein the per cent of soluble As_2O_5 was even considerably smaller than that found in the check. These results are significant and suggest that skimmed milk could be used more advantageously as a spreader. That skimmed milk prevents the forma-

tion of water soluble arsenic from acid lead arsenate has been also observed by Thatcher and Streeter (19) in their Chemical Studies of the Lime Sulfur Spray. Furthermore, the spreading properties of skimmed milk were found by T. J. Headlee (8) to equal those of Kayso. In addition to the above facts it should be mentioned here that powdered skimmed milk is considerably cheaper than Kayso.

The data in Table 1 further show that while four pounds of hydrated lime decrease considerably the amount of soluble arsenic, they do not entirely eliminate it since 0.65% of As_2O_5 was still found in mixture No. 8. In view of this fact it became of interest to determine the proportion of hydrated lime necessary to take up all the soluble arsenic that may be liberated from the acid lead arsenate present in this spray. Accordingly 100 c.c. samples were prepared in which the sulfur, "Kayso" and lead arsenate were in the same proportions as those present in the sulfur lime dry-mix, while the amount of hydrated lime was varied from 0.25 pound to 10 pounds equivalents in fifty gallons of spray. The mixtures were submitted to the same treatment as in the previous experiments and the water soluble arsenic determined at the end of six days.

TABLE 3.—WATER SOLUBLE ARSENIC OBTAINED FROM SULFUR-LIME DRY-MIX SPRAY CONTAINING VARYING CONCENTRATIONS OF HYDRATED LIME KEPT FOR SIX DAYS AT ROOM TEMPERATURE

Mixture No.	Composition	As_2O_5 1	2	Average
15	$PbHAsO_4$	2.43	1.96	2.19
16	$PbHAsO_4$, Sulfur, Kayso, No $Ca(OH)_2$	5.67	4.75	5.21
17	" " " 0.25 lb. "	5.10	4.46	4.78
18	" " " 1 lb. "	1.40	1.20	1.30
19	" " " 2 lb. "	0.90	0.76	0.83
20	" " " 4 lb. "	0.56	0.58	0.57
21	" " " 6 lb. "	0.57	0.43	0.50
22	" " " 8 lb. "	0.41	0.41	0.41
23	" " " 10 lb. "	0.34	0.48	0.41

The results of duplicate analyses presented in Table 3 show again that the highest amount of water soluble arsenic is formed in the spray mixture where no $Ca(OH)_2$ is present. The As_2O_5 gradually decreases with increasing increments of $Ca(OH)_2$, reaching its minimum (0.41%) where hydrated lime equivalent to 8 pounds was used. Higher increases of hydrated lime did not produce any further decreases in the As_2O_5 as may be seen from mixture No. 23, where ten pounds of $Ca(OH)_2$ was applied. These results proved definitely that hydrated lime decreases the amount of soluble arsenic but does not entirely eliminate it. Furthermore, when sprayed on foliage still higher quantities of soluble

As_2O_5 may be expected because, by spreading the spray in thin layers on large surfaces, under atmospheric conditions, a considerable part of the $Ca(OH)_2$ may become carbonated and liberate enough soluble arsenic to cause foliage injury.

In conclusion the author takes this opportunity to express his indebtedness to Dr. T. J. Headlee for valuable suggestions freely given throughout the experiment.

Summary

Chemical investigations of the sulfur lime dry mix spray were carried out with the purpose of studying the reactions involved in the formation of water soluble arsenic. Twenty-three 100 c.c. mixtures of spray were prepared, each one of which contained an equal quantity of acid lead-arsenate but varied in its composition and concentration of the other three ingredients ($Ca(OH)_2$, Sulfur, Kayso). All mixtures were kept at room temperature for six days and the water soluble arsenic determined. The results from these experiments indicate that:

1. Sulfur alone in absence of both Kayso and $Ca(OH)_2$ does not appreciably influence the decomposition of acid lead arsenate.

2. When Kayso is added to $PbHAsO_4$ in absence of $Ca(OH)_2$ large quantities of soluble As_2O_5 are formed. This is apparently brought about by the lime of the Kayso which becomes partially carbonated, upon standing. This phenomenon was not observed when either casein or skim milk was substituted for Kayso.

3. Calcium carbonate in solution reacts directly with the lead arsenate, forming soluble arsenic salts.

4. The presence of an excess of hydrated lime greatly retards the formation of soluble arsenic but does not entirely eliminate it.

5. The smallest quantity of soluble arsenic was found when six or eight pounds of hydrated lime were used in fifty gallons of spray.

6. Sulfur lime dry mix spray could be made more stable chemically by substituting powdered skimmed milk for Kayso.

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A meeting was held in Michigan on June 23, 24, and 25, for the purpose of discussing and studying the virus diseases of the raspberry with the object of familiarizing inspectors with the appearance of diseased plants and with methods to be employed in controlling the various diseases. Representatives were in attendance from the Department of Agriculture and from Ontario, New York, Ohio, Indiana, Illinois, Wisconsin, Minnesota, and Michigan. In the case of some of the states mentioned, the entire corps of nursery inspectors was present. During the course of the meeting many infected plantings were visited in the four southwestern counties of Michigan, and the effect of roguing in controlling the diseases was observed. At the evening meeting, held in the Vincent Hotel at Benton Harbor, on June 24, addresses were made by several men from the Department of Agriculture, and from the state experiment stations.

THE PENETRATION OF A CONTACT OIL SPRAY INTO THE BREATHING SYSTEM OF AN INSECT[1]

By FRANKLIN C. NELSON, M.S., *Crop Protection Institute Fellow, New Brunswick, N. J.*

It has been generally known that sprays such as Nicotine Sulphate or Pyrethrum extract accomplished their results by the volatilized gas entering the breathing system of an insect and attacking the nervous system, causing a gradual paralysis followed by death.

Shafer, Geo. D., (1) colored kerosene with Sudan III and thoroughly sprayed or dipped grasshoppers (*Melanoplus femoratus* Burm.) tomato worms and aphis into the oil. After dissecting these insects, he found more or less of the red oil in the larger tracheae but none in the smaller branches of the breathing system. Tests with kerosene emulsion and the emulsions of the miscible oils colored with indigo-carmine and with safranin gave similar results.

Dewitz, J., (2) in discussing contact insecticides, does not believe that either liquids or powders can enter the spiracles in sufficiently large quantities to cause the death of the insects by suffocation.

McIndoo, N. E., (3) in his work with nicotine sprays and colored water, found that they did not penetrate the spiracles. He says, "Since it has been shown that spray solutions, as applied under practical conditions, do not pass into the tracheae, a study of the spiracles of the aphis, coccids, and larvae that have been used in the experiment shows that it is practically impossible for aqueous solutions to enter the spiracles. The mouths of the spiracles of all these insects except the coccids, are guarded by pseudohairs, which are outgrowths from the chitinous linings of the spiracles and by the rims turning inward and sometimes downward. The spiracles of the coccids are practically unprotected while those of aphids bear a few hairs. The small size of these spiracles seems to be the best reason why aqueous solutions cannot readily pass into the tracheae."

These investigations seem to prove that the volatile gas, then, is all that penetrates the breathing system. Work carried on with "Flit" a commercial insecticide from the Standard Oil Co. of New Jersey, led the author to believe that more than the gas penetrated the breathing system. Bees (*Apis mellifica*) and flies, (*Muscina stabulans* and

[1]This paper is a partial report resulting from an investigation of the properties of Flit, conducted by the Crop Protection Institute and financed by the Standard Oil Company (New Jersey). The work was carried out in cooperation with the New Jersey Agricultural Experiment Station, and under the immediate direction of Dr. T. J. Headlee.

Stomoxys calcitrans), when sprayed, were overcome and killed in a few minutes, but when placed in a bell jar filled with the spray as a gas, the bees did not die in less than 4 to 5 hours and the flies from 2 to 3 hours. This test was repeated ten times with a minimum of ten bees or flies in each test and the results were constant. Tests were then made by spraying equal volumes of "Flit" into tightly stoppered bell jars. In one, the insects in cages, were lowered into the jar while the spray was floating in the air in fine particles. The other jar was allowed to stand twelve hours so that only a gas would be present. Ten runs were made and the bees in the vapor died at least two hours sooner than those in gas only.

"Flit" was colored with National Oil-Red O dye and sprayed on meal worms (*Tenebrio molitor*). These were semi-transparent and the movement of the liquid in the breathing system, could be watched without dissection. The colored spray entered the spiracles, when open, and moved on up into the smaller branches of the tracheae. The spray did not enter where the spiracle was closed, but as soon as the insect became overcome, the liquid covering the spiracular opening, passed thru it. Dissections of sprayed larvae showed red spray present in the very minute branches, a few minutes after spraying.

Direct Spray

The work was then carried on with adult honey bees. Ten bees were sprayed with 1.2 c.c. of colored Flit until a thin film wet the body, and immediate dissections were made. In almost every case examined, the large tracheae and air sacs contained liquid spray or color. In a few cases, the spray was located in a minute tube immediately after spraying. Observations on a few of these bees showed the movement of the liquid spray up into the smaller tubes. In some, the movement was rather fast and in others slow and jerky, the rapidity presumably dependent upon the volume of gas present in the tracheal tubes and its removal either by absorption into the liquid or escape past the liquid and out of the spiracles.

Other lots of bees were sprayed and not dissected for twelve hours. Both ventral and dorsal dissections of the abdomen showed liquid spray in a large number of the minute branches of the tracheae surrounding the digestive tract and nervous system.

Twelve bees were then dipped into liquid "Flit" for 30 seconds. They died at once and an immediate examination showed colored liquid throughout the breathing system, not only in the large tubes, but also in the minute branches leading into the various body systems.

Air Float

Thirty bees, in lots of ten each, were treated with air float instead of direct spray. They were caged to prevent them from getting into any liquid spray on the sides or bottom of the bell jar. As soon as partially overcome, 10–15 minutes, they were removed and examined. The outer surface of the bees was coated with liquid. The air-sacs showed a distinct red color but no spray was seen in the smaller branches of the breathing system.

Other lots of bees were left in the jars five hours before examination was made. These showed a coloring of the air-sacs and many small branches contained red liquid. It apparently took a little time for the smaller branches to be filled with liquid.

One lot of ten bees was treated as above but left in the jars twenty hours. Examination showed liquid in the very smallest tracheal branches. The nerve ganglia were colored but the connectives were not. This coloring of the ganglia does not occur under one hour as other tests showed but the minute breathing tubes do contain color in one hour. A four hour test did not show color in the ganglia. Fifteen hour treatments in air float gave colored ganglia, muscle tissue and some of the Malphigian tubes also showed color. The minute tubes entering the ganglia contained liquid which probably diffused through the nerve cells as they were killed and thus colored the ganglia. It was not determined whether the muscles and Malphigian tubes were colored in this manner but no free color was seen in the body fluids outside the tracheal tubes and it is very probable that the spray entered them through the tubes.

Kerosene Treatment

A repetition of the above series of tests was made with kerosene colored with the same dye. With the exception of the rate and percentage of killing, no difference in results was seen. They died much slower and usually only about 60% were killed with the same volume of spray that killed 100% with "Flit." This showed that the mere blocking of the spiracles or tracheal tubes was not responsible for any great degree of the kill, but the active agent in "Flit" was brought in closer contact and in greater concentration in the breathing system and thus caused a rapid kill.

Dye Carrier

The possibility of the dye leaving the spray liquid and penetrating through the chitinous layer of the tracheae and passing from cell to cell in the epithelium, needed to be settled. Before spraying, the air

tubes were empty and after spraying, it could easily be seen that they contained a red colored liquid which could be made to flow either forward or backward in the tube by means of pressure. The color in tubes through which the spray had passed did not show an even flush of color as would probably have been true if the cells had been dyed instead of a finely divided deposit on the chitinous layer. Dry powdered dye was introduced into the abdominal cavity of several bees and left for twenty-four hours. Examination showed only an exceptional trace of dissolved dye. Powdered dye and honey mixed together was fed to twelve live bees. Examination after twenty-four hours showed dissolved color throughout the digestive tract as well as the honey stomach, but the color was more of a brownish red than a deep pink red, as was secured when the dye was dissolved in kerosene. Most of the dye remained in its original form in the large and small intestines. The dye that did dissolve probably came into contact with fat bodies as it is an oil soluble dye.

None of the dye dissolved in the mixture of honey nor in a water solution.

The final test, however, was to remove several pieces of tracheae containing colored liquid, washed thoroughly to remove any adhering fat or oil and then dipped in a small dish of distilled water and the liquid then squeezed out of the tube. In every case, a distinct colored film of oil formed on the surface of the water, showing that the red color was being carried both by the insecticide "Flit" and by the kerosene check spray and not passing from cell to cell.

Conclusion

From the above results, it may readily be seen that with a spray of kerosene or the insecticide "Flit," a greater penetration of the liquid into the tracheal tubes takes place, than is usually supposed. Undoubtedly, the surface tension of the spray is directly responsible for this penetration and might easily increase or decrease the efficiency of a spray by causing a greater or lesser penetration and thus reduce the concentration of the toxic principle in near proximity to the nervous system.

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ETHYLENE DICHLORIDE-CARBON TETRACHLORIDE MIXTURE; A NEW NON-BURNABLE, NON-EXPLOSIVE FUMIGANT

By R. T. COTTON, *Entomologist, Bureau of Entomology*, and R. C. ROARK, *Associate Chemist, Bureau of Chemistry, U. S. Department of Agriculture.*

ABSTRACT

A new fumigant consisting of 3 parts by volume of ethylene dichloride and 1 part by volume of carbon tetrachloride is very effective against stored product pests. It is cheap, non-inflammable, non-explosive, non-injurious to stored commodities and is not dangerous to human life. It is about five times as toxic as carbon tetrachloride.

INTRODUCTION

During the course of a systematic search for new, effective, and non-hazardous fumigants, a number of aliphatic compounds have been tested that appear to be of considerable value. In view of the urgent need of such fumigants it seems desirable to publish from time to time preliminary accounts of promising compounds without waiting for the completion of the investigation. Information regarding ethylene dichloride is presented at this time.

HISTORICAL

Ethylene dichloride has been tested in regard to its anaesthetic action, its action on yeast cells, white mice, blood vessels, etc., but has never been tested as an insecticide except by the writers and their associates. In a previous publication[1] a report was given regarding tests with ethylene dichloride in bell jars only. These preliminary tests were not very favorable and no large-scale tests were made at that time.

PHYSICAL AND CHEMICAL PROPERTIES OF ETHYLENE DICHLORIDE

Ethylene dichloride is also called ethylene chloride, but its correct designation is s-(meaning symmetrical) dichloroethane, or 1, 2-dichloroethane. In German it is known as alpha, beta-dichloräthan, äthylendichlorid, and äthylenchlorid. In the older chemical literature ethylene dichloride is called elayl chloride and the "oil of the Dutch chemists."

Its empirical formula is $C_2H_4Cl_2$, and its structural formula is CH_2Cl–CH_2Cl, also written as $(CH_2Cl)_2$.

Ethylene dichloride is a colorless liquid with an odor like chloroform. It is about 1¼ times as heavy as water; one gallon of ethylene di-

[1]Neifert, I. E., Cook, F. C., Roark, R. C., Tonkin, W. H., Back, E. A. and Cotton, R. T. Fumigation Against Grain Weevils With Various Volatile Compounds. U. S. D. A. Bull. No. 1313, p. 5, 1925.

chloride at 60°F. weighs 10.4 pounds. Its vapor is over 3 times as heavy as air, which enables it readily to displace the latter if applied from above and penetrate upholstery, rugs, clothing, merchandise, etc., and reach the insects inside.

From the vapor pressure and molecular weight of ethylene dichloride it may be calculated that a room of 1,000 cubic feet capacity will hold 20.5 pounds of ethylene dichloride vapor at a temperature of 20°C. If more than 20.5 pounds of the fumigant are added to a room of this size, the excess will remain as a liquid and will not evaporate. At higher temperatures an increased amount of ethylene dichloride will evaporate, and at a lower temperature a smaller amount.

Ethylene dichloride boils at 83.7°C. and freezes at —36°C. It is only very slightly soluble in water; 100 grams of water at 20°C. dissolve 0.869 gram of ethylene dichloride.

Cost of Fumigant

Ethylene dichloride is made by passing ethylene gas into liquid chlorine at a low temperature. Both of the materials from which it is made are cheap and are commercially available in large quantities. In "Chemical Markets" for June 9, 1927, ethylene dichloride in 50-gallon drums is quoted at 11 cents per pound, and in tank cars at 6 cents per pound, f.o.b. This price is about the same as that of carbon tetrachloride which in the same journal is quoted in 1400-pound drums at 7 to 7½ cents per pound, delivered, and in drums in car lots at 6¾ cents per pound, delivered.

Inflammability

When ethylene dichloride is ignited by a lighted match, it will continue to burn, but only with difficulty. It is on the border line between the fire-extinguising chlorinated hydrocarbons and the combustible hydrocarbons. In order to make it perfectly free from fire hazard when used as a fumigant, it is necessary to add 1 volume of carbon tetrachloride to 3 volumes of ethylene dichloride. This mixture will not burn, and in fact can be used as a fire extinguisher.

Ethylene dichloride and carbon tetrachloride mix readily in all proportions and the mixture has physical properties intermediate between those of its ingredients. Since the boiling points of the two constituents are close, 83.7°C. for ethylene dichloride and 76.8°C. for carbon tetrachloride, the mixture evaporates almost as if it were a single compound.

Effect of Mixture on Various Commodities

The mixture of ethylene dichloride and carbon tetrachloride has no corrosive action on metals nor any bleaching or staining action on textiles of any sort, and when vaporized in a fumigating chamber may be applied freely to rugs, carpets, woolens, linens, mohair, clothing, upholstered furniture, etc., without fear of damage.

Effect Upon Human Life

When the vapor of ethylene dichloride is inhaled it has an anaesthetic action very much like that of chloroform, although less rapid. Unless breathed in high concentrations and for a protracted period of time, no harmful results may be feared in working with this compound.

Insecticidal Action

After extensive experiments in the laboratory had indicated that ethylene dichloride was effective as a fumigant against stored-product insect pests, tests were conducted on a larger scale. For this purpose a standard commercial fumigating vault of 500 cu. ft. capacity was used. It was of very tight construction and adapted to the fumigation

Table 1.—Fumigation Tests with Ethylene Dichloride, Carbon Tetrachloride and Mixture of the Two

Fumigant used	Dosage, lbs. per 1,000 cu. ft.	Length of exposure	Temp.	Per cent killed *Anthrenus vorax*	*Tineola bisselliella*	*Attagenus piceus*
Ethylene dichloride alone	4	24 hrs.	83°F	80	100	90
do	5	24 hrs.	75°F	90	95	90
do	6	24 hrs.	80°F	100	100	100 ✓
Ethylene dichloride 3 parts, carbon tetrachloride 1 part by volume	5	48 hrs.	70°F	100	100	100
do	6	24 hrs.	65°F	95	90	80
do	6	24 hrs.	85°F	100	100	100 ✓
do	8	24 hrs.	65°F	50	60	85
do	8	24 hrs.	75°F	100	100	100
do	9	24 hrs.	65°F	85	90	100
do	9	24 hrs.	75°F	100	100	100
do	10	24 hrs.	65°F	90	100	100
do	10	24 hrs.	75°F	100	100	100
do	12	24 hrs.	65°F	100	100	100
Carbon tetrachloride alone	25	24 hrs.	75°F	90	90	90
do	30	24 hrs.	85°F	100	100	100 ✓

of furniture, rugs, clothing, furs and other commodities. Insects used in the experiments were chiefly, the clothes moth, *Tineola bisselliella*, the furniture beetle, *Anthrenus vorax*, and the black carpet beetle, *Attagenus piceus*. In one case other insects were used. The following table contains data regarding the insecticidal action of: ethylene dichloride alone, a mixture of 3 volumes ethylene dichloride and 1 volume carbon tetrachloride and carbon tetrachloride alone, when used at various concentrations, at different temperatures, and with different periods of exposure.

In the above experiments 40 insects of each species were placed in cotton-stoppered, glass vials, and rolled up in rugs, or buried in the stuffing of upholstered furniture. The fumigant was applied by pouring it into a shallow pan near the ceiling of the vault.

Amount of Fumigant Required

The data in Table 1 indicate that 6 lbs. per 1000 cubic feet of space of the 3-to-1 mixture of ethylene dichloride and carbon tetrachloride is 100% lethal when used in a gas-tight vault, with a temperature of 85°F. and a 24-hour exposure. The same dosage at 65°F., however, does not give a perfect kill. A dosage of 12 lbs. of the mixture per 1000 cu. ft. is 100% lethal at temperatures above 65°F. For general fumigation work in gas-tight chambers it is recommended that a dosage of 5 quarts, or 14 lbs. of the mixture per 1000 cu. ft. be used. In comparison with carbon tetrachloride the mixture appears to be about 5 times as toxic at ordinary temperatures.

Powers of Penetration

All experiments with this mixture indicate that the fumigant has excellent powers of penetration. Insects rolled up in thick rugs and buried in overstuffed furniture are readily killed. In a special test, flour beetles, *Tribolium confusum*, and rice weevils, *Sitophilus oryza*, were sealed up in cartons of cereal: specimens of the Indian meal moth, *Plodia interpunctella*, and the saw-tooth grain beetle (*Oryzaephilus surinamensis* were buried in boxes of candy and other insects were buried in piles of clothing and rugs. A dosage of 14 lbs. of the mixture per 1000 cu. ft. at 80°F. gave a perfect kill.

Conclusion

The new mixture appears to be well adapted for general fumigation work in air-tight vaults. It is cheap, has no fire hazard, is non-injurious to furniture or fabrics, is simple to use and is not dangerous to human life when used as recommended.

IMPORTANCE OF PATENT LITERATURE TO ECONOMIC ENTOMOLOGISTS

By R. C. Roark, *Insecticide and Fungicide Laboratory, Miscellaneous Division, Bureau of Chemistry, Washington, D. C.*

Abstract

The patent literature is of importance to the economic entomologist because: (1) it often describes for the first time a valuable new insecticide; (2) it gives the composition of some proprietary preparations sold under extravagant insecticidal claims; (3) and it describes new apparatus and processes for the application of insecticides and for the destruction of insects by physical means. Paradichlorobenzene, sodium fluoride and chloropicrin were first described as insecticides in the patent literature.

Among the means employed by economic entomologists for the control of injurious insects, the use of insecticides is one of the most valuable. In order to select and apply insecticidal materials to the best advantage, it is necessary not only to know the life history of the insect to be controlled, but also to know what results have been obtained by other workers with the insect in question, or with other insects of similar habits, using various insecticides. Information regarding materials used in destroying or repelling insects or preventing or mitigating their ravages is given in the chemical, pharmaceutical, medical, veterinary, and patent literature, as well as in entomological and agricultural journals. The biological, chemical, and medical literature is abstracted in periodicals issued at regular intervals. The patent literature, however, is never mentioned in any of the medical or biological abstract journals, and the chemical abstract journals contain abstracts only of such patents as relate to the manufacture or use of various chemicals as insecticides. Patents relating to devices for applying insecticides (such as dusters, sprayers, nozzles, and fumigators) and those relating to insect traps and devices for collecting, crushing, cremating, electrocuting, or otherwise physically controlling insects are not abstracted anywhere.

In order to supply this deficiency, the Insecticide and Fungicide Laboratory of the Bureau of Chemistry has started a quarterly review which gives abstracts of the United States patents relating to insecticides and fungicides. This review, in mimeographed form, is sent to anyone requesting it. It is planned to extend this review to include foreign patents.

The value of the patent literature to economic entomologists and others searching for new and better means of insect control may be summarized as follows:

(1) A study of the patent literature frequently brings a valuable new insecticide to the entomologist's attention long before he would become cognizant of it in any other way. For example, the use as insecticides of paradichlorobenzene, sodium fluoride, and chloropicrin was described in patents several years before American economic entomologists became aware of their existence. Paradichlorobenzene was patented in Germany in 1911 (Ger. Pat. 258, 405), and in 1912 in England (British Patent 19,688 (1912); C. A. *8* (1914): 2039) and in 1914 in the United States (U. S. Patent 1,097,406) for use in destroying moths and insects infesting hides, furs, and museum specimens. The first publication by an American entomologist mentioning this compound was that by Duckett (U. S. Dept. Agr. Bull. 167) in 1915. Publication describing its use against the peach tree borer by Blakeslee (U. S. Dept. Agr. Bull. 796) was not made till 1919. Sodium fluoride as an insecticide was described in the patent literature by Higbee (British Patent 8,236 (1896)) in 1896, but it was not until 1915 that an entomological article mentioning this compound appeared in this country (Mich. Agr. Exp. Sta. Tech. Bull. 21). Chloropicrin as an insecticide was patented in 1907 in England by Howorth (British Patent 20,387 (1907)), but ten years elapsed before it was rediscovered by an American entomologist (J. Agr. Research *10* (1917): 365). Is it not reasonable to believe that if abstracts of these patents had been available to American entomologists the present application of these compounds as insecticides would have been worked out many years sooner?

(2) A knowledge of the patent literature is valuable to economic entomologists in protecting the public against worthless proprietary preparations. Many of these are patented and their composition given in the patent literature. Most of them consist of a mixture of materials, the insecticidal value of which is well known. A knowledge of their composition enables the entomologist to form an intelligent opinion of their worth.

(3) Devices for applying insecticides, such as sprayers, dusters, spray nozzles, and fumigating appliances, are constantly being invented. The first information about them is to be obtained from the patent literature. New insect traps, fly swatters, insect barriers, insect attractants and baits, sticky fly paper, and apparatus and processes for destroying insects by crushing, burning, or electrocuting, or by the application of heat, cold, vacuum, or X-rays are first described in the patents issued to their inventors.

APPARATUS AND METHOD USED TO REMOVE PINS FROM INSECT SPECIMENS

By J. E. R. Holbrook, *Bureau of Entomology, Melrose Highlands, Mass.*

It is often desirable, and sometimes necessary, to remove pins from mounted insect specimens. This is a tedious operation, and valuable specimens are apt to be injured in the process, especially when they have been pinned for a long time.

A simple method for removing pins from museum specimens has been devised at the gipsy moth laboratory at Melrose Highlands, Mass. This method is so satisfactory that its use would be more general were the method known. It consists of heating the pin by allowing a low

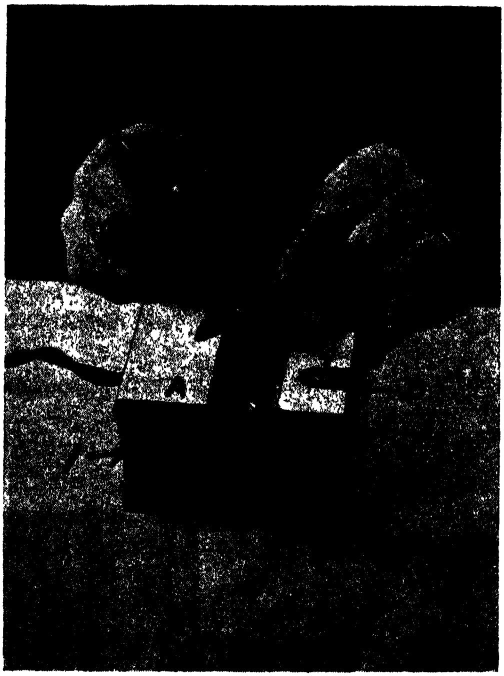

Fig. 24.—Apparatus for removing pins from mounted insect specimens

voltage of electricity to run through it and at the same time of gently pushing the specimen down with a small pair of forceps, as illustrated in the accompanying figure.

A small "step down" transformer, such as is used for operating

mechanical toys, regulates the voltage. The transformer used at the gipsy moth laboratory is constructed so that voltages ranging from 3 volts to 25 volts can be obtained. A current of 3 volts is passed through the pin which is to be removed. A sheet of pressed cork (A) is placed on the top of the transformer and several pieces of tin or lead foil (B) pressed together are fastened to the cork. A thin piece of brass sheeting bent to form a right angle (C) is attached to binding post No. 1 so as to press firmly on the foil. A second piece of brass sheeting (D) is attached to binding post No. 2. It is bent the same as the previous piece, but the top of it rests on the cork, and on its upper surface is soldered a short piece of No. 18 gauge insulated copper wire.

The pin which is to be removed is stuck through the foil into the cork, as shown in the illustration, and the current turned on. The operator connects the free end of the No. 18 gauge wire to the head of the pin and at the same time, with a pair of forceps, gently presses on top of the specimen. Very quickly the pin becomes heated and the gentle pressure on the specimen moves it down to the bottom of the pin, where it is removed without injury. If the pin has been covered with a "finish" a better contact is made by slightly scraping the point and head with a knife or small file before placing it in position for removal. The contact should not be held longer than is necessary for the removal of the insect as the pin will become red hot and scorch it. An operator will quickly acquire this technique and find that pins can be easily removed by this method without injury to the specimens.

In the absence of the electrical equipment described above, a satisfactory arrangement may be made by the use of two 1½ volt dry batteries. These may be connected either in series or in parallel. The pressed cork and foil are prepared as in the previous case. No. 18 gauge wire is used and one wire from the batteries is attached to the foil and the other is brought in contact with the pin that is to be removed.

Scientific Notes

Concerning Oviposition of the Codling Moth: The winter of 1925–26 in the Yucaipa-Beaumont district in California was unusually mild. This fact probably along with other conditions resulted in many unharvested apples hanging on the trees throughout the winter and until June and July of the following summer. In case of about one hundred trees of the Winter Banana variety, which were under especial observation, the apples were scarcely shrivelled at all and gave forth a rich apple odor during most of the period when the moths of the first brood were active. It was thought probable that the moths would lay many eggs on the old apples

especially during the early part of the season when the apples of the new crop were small. On the contrary, however, frequent inspections were made but not a single egg was found on any of the old apples. Neither did there seem to be any tendency for the moths to lay eggs on the leaves near these apples.

RALPH H. SMITH,
Citrus Experiment Station, University of California

Biological Control of the Codling Moth (*Carpocapsa pomonella.*) The initial experiment carried on this spring by the Saticoy Walnut Growers Association in controlling the codling moth by means of its natural parasite, *Trichogramma minutum*, indicates that biological control of this pest may be a commercial success.

Thousands of the parasites are being liberated at the centers of infestation. A high percentage of codling moth eggs are found to be parasitised within two weeks after the liberation. Normal egg-parasitism is so light that it does not interfere in determining the effect of the liberations. On a large walnut tree parasites were observed stinging the moth eggs on the side opposite the point of liberation. Two parasites were found on a single egg.

Experimental work started in August 1926 with ten females reared from tortrix eggs. Using the Angoumois grain moth as host in the rearing room a daily production of two hundred thousand *Trichogramma* has been attained. The egg production of the moths obtained from a ton and a half of infested Indian corn amounts to about three hundred thousand eggs daily. The original bin of corn infested during the summer of 1926 is still producing moths in abundance.

A rapid reproduction of *Trichogramma* is obtained at a uniform temperature of about 83 degrees. At this temperature its life-cycle is eight days.

A daily production of a million parasites is the goal set for the Association Insectary. A limited amount of *Trichogramma* in the pupal stage are available for distribution at the rate of 10c per thousand in quantities of not less than 10,000.

STANLEY E. FLANDERS

A Note Regarding the Distribution of the Alfalfa Weevil. Since the publication of my paper (Jour. Agr. Res. 30:479, 1925) on this subject, I have, on various occasions, noted some confusion regarding the findings in that paper. An example is the comment of Newton (Jour. Econ. Ent. 19:371, 1926) that the infestation in eastern Wyoming upsets those conclusions. On page 479 of my paper, I stated that the work was an attempt to determine the "probable economic distribution" of the species, but neglected to define this term. The intention was to distinguish the *economic* distribution, or area of damage, from the *systematic* distribution, within which specimens may be captured. I did not intend, by any means, to imply that the weevil would not be found outside the zones as there outlined, but I did intend, and still maintain, that it will do no great damage elsewhere.

The recently discovered infestation in eastern Wyoming does not distrub the major premise of my paper. The weevil, although apparently established in this region, has done little or no damage. Corkins (Jour. Econ. Ent. 19:375, 1926) states:

"There are two areas in this territory which show some slight damage this year. However, the growers themselves had never detected it and didn't know that anything was damaging their crop."

This is far from being "economic damage" in the usual sense of the word. Further, if the reader will examine my paper, he will find most of the eastern slope of the Rockies included in the "zone of possible occurrence," defined as a region where the weevil will "probably not maintain itself, but. . .may become of minor importance after a series of favorable seasons." The major climatic factor used to exclude the weevil from the northern Plains is winter temperature, combined with light snowfall. Anyone interested in climatology will find in the Monthly Weather Review for February 1927, p. 81, a note on the remarkable series of mild winters from 1917–18 to 1926–27. These conditions have also enabled many other insects temporarily to extend their ranges.

WILLIAM C. COOK, *University of Minnesota*

An Introduced Cabbage Weevil. On June 22, 1927, specimens of a small weevil were received from Hartsdale, Westchester County, N. Y., which were reported as being injurious to seedling cabbage. Mr. L. L. Buchanan of the U. S. National Museum, Washington, D. C., determined these as *Ceutorhynchus erysimi* Fab. He believes this species has not been definitely recorded from the United States heretofore.

Nearly all of the plants in a small field were destroyed by this weevil. The cabbage was sown in hills thirty inches apart, each way, with five or six seeds in each hill. Injury took place when the plants were one or two inches high. Applications of a dust, arsenate of lead one part, hydrated lime 4 parts, was moderately effective in preventing injury.

Several specimens of *C. erysimi* were found on a mustard plant which grew near the cabbage. In Germany Urban (Ent. Blatter 20:86. 1924) has reared this species from larvae infesting the stems and roots of Shepherd's Purse, *Capsella bursa-pastoris*. Upon reaching maturity in June and July the larvae enter the soil to pupate. The pupal period is two or three weeks. Other workers have taken the adults on cruciferous weeds but no record was found of *C. erysimi* as a pest of cultivated *Cruciferae*. The species is apparently common and widespread in the old world. Schultze (Deutsche Ent. Zeit 1902:205) gives its distribution as Europe, Asia Minor, Algeria and Siberia.

P. J. CHAPMAN, *Cornell University, Ithaca, N. Y.*

Notes on *Eutettix tenella* (Baker) in Northern California, 1927. The overwintering population of *E. tenella* in the San Joaquin foothills, which is the only permanent overwinter breeding ground in northern California, was enormous and a very serious infestation was threatened to all of the beet fields north of the Tehachapai range of mountains. In early March some very heavy downpours occurred in the foothill breeding area south of Coalinga from Coalinga to Maricopa and Bakersfield and destroyed the maximum emergence of E. *tenella*. These hoppers were mostly in the first and second instars. In the latter part of March and early April, a very serious aphis infestation destroyed the bulk of the short filaree in the little Panoche and Tracy areas on which the most of the eggs of *E. tenella* were laid and to some extent this same thing occurred in the area between Coalinga and little Panoche. Altogether about three-fourths of the possible crop of *E. tenella* was destroyed. At the time of the migration of *E. tenella* from the San Joaquin foothills, east winds were blowing, carrying a large number of beet leaf hoppers from the San Joaquin to the

Salinas Valley. As a consequence the Salinas Valley has a serious infestation and the Sacramento Valley, which is an extension of the San Joaquin Valley to the north, has a light infestation. The writer has proved by conclusive research that the *E. tenella* migrate as far as 85 miles in one night and that they make a second flight from the floor of the San Joaquin Valley to the Sacramento Valley. The time of flight from the San Joaquin to the Sacramento Valley has been predicted accurately for two seasons by the writer. In 1926 and also in 1927 there have been three flights from the San Joaquin to the Sacramento Valley. The population in certain portions of the San Joaquin Valley was noticed to increase on certain atriplexes as follows: April 22—4; May 3—18; flight took place on night of May 4; May 1—5; May 9—10; May 12—12; flight took place on night of May 12; May 13—6; May 17—6; June 6—6. No increase in population in the section examined occurred after May 12 on which date the last flight to the Sacramento Valley occurred. On June 6 nymphs were beginning to be abundant. By using this system the writer can determine exactly when it is safe to plant late beets in the Sacramento delta. Flights from the San Joaquin to the Salinas Valley have been predicted each year since 1922 by the writer, but he has not been generally believed until 1927 when all doubt of such flights of *E. tenella* have been removed.

In connection with insect forecasting, the writer noted the presence of enormous numbers of aphis in the San Joaquin foothills in March and predicted a serious outbreak of aphis for April in the San Joaquin Valley. This outbreak occurred. Also the writer warned growers in the Sacramento Valley of the presence of large numbers of aphis on ditchbanks in time to do effective control work. It is the opinion of the writer that this side of economic entomology has been vastly neglected. Mr. Walter Carter of U. S. D. A., at Twin Falls, Idaho, is doing valuable basic work along this line.

E. A. SCHWING, *Entomologist, Spreckels Sugar Co.*

The Argentine Ant an Odorous Species. During the past thirteen years, or since the publiction of Bulletin 122 by the Bureau of Entomology, entitled, "Th Argentina Ant," the opinion has been prevalent that the worker of this species is an odorless ant. This means that when workers are crushed between the fingers the ants, *Iridomyrmex humilis*, give off no perceptible odor. This belief no doubt originated with the publication of the above bulletin, which on page 31 has the following statement concerning this subject, "Argentine workers, when crushed between the fingers give no perceptible odor and this readily distinguishes them from their closest relative, *Iridomyrmex analis*, as well as from their remote relatives, the species of *Tapinoma*."

The writer being able to distinguish this species without crushing the workers readily accepted the statement for years and even went so far as to cite this characteristic as a means of distinguishing the workers of the Argentine ants from those of closely allied species.

Recently, however, he was surprised to detect a very characteristic, somewhat greasy or musty odor about the crushed ants. This was immediately called to the attention of other State Plant Board workers, who readily agreed with the writer as to the presence of the odor and the nature of its smell. Since this discovery Argentine ant workers have been tested out in various sections of the state and in every case the investigator has found the same characteristic odor present.

Whether this odor has been induced by some special food, or whether the workers

could have acquired an odor since the introduction of the species into this country is not known. However, either view seems rather untenable, hence, the writer is led to conclude that the Argentine ant worker does possess a typical musty or greasy odor. M. R. SMITH, *State Plant Board, Agricultural College, Miss.*

Another Poisonous Caterpillar. In June 1925, while on vacation at Castle Dale, Utah, I was told of a poisonous caterpillar which had caused considerable annoyance during the preceding three years. It had been especially troublesome to barefoot children playing in the shade of large boxelder trees, often causing quite painful injuries. I was especially interested in it because from the numerous accounts of my friends it must have been introduced since I had left there in 1916. As I was able to find only pupae these were sent to Washington, D. C., and were determined by Mr. Heinrich as *Apatela americana* Harris, which he said was not poisonous.

In July 1926, while again on vacation in that vicinity, I questioned many people who had been injured by these caterpillars. In some instances the injury had been so severe as to require medical attention. Apparently most every one knew of the poisonous caterpillars and knew them by sight as there had been considerable agitation about cutting down all boxelder trees in order to rid the country of their chief host plant.

I collected a number of the larvae of different sizes and sent them to Washington. They were identified by Messrs. Busck and Heinrich who said that they were certainly not poisonous. However, one of the caterpillars which I sent to them had been taken immediately after crawling across my little girl's bare foot. It caused a distinct welt across her foot, the swelling and dermatitis of which caused considerable pain and annoyance. This seemed to be the typical injury caused as some people said that the caterpillar caused a painful stripe just as if they had been hit with a whip.

Although Mr. Busck and Mr. Heinrich say that this caterpillar is not poisonous, I have the statement of more than a dozen reliable persons who have been injured by it, so that it certainly is poisonous under some conditions.

It is not surprising that it is poisonous as other species in the same genus are known to be poisonous. Paul A. Gilmer, in "A Comparative Study of the Poison Apparatus of Certain Lepidopterous Larvae," Annals of the Ent. Soc. of A., Vol. 18, No. 2, page 203, reports *Apatela populi* Ril. and *A. oblinita* Sm. and Abb. as being poisonous. He says that it is very probable that cases of caterpillar rash are more widely spread than is commonly supposed and it is very probable that many of the so-called "hives" and other summer urticarias are due primarily to caterpillar hairs.

A. O. LARSON, *Alhambra, Calif.*

ENDOWMENT COMMITTEE
AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

At the last annual meeting the President was authorized to appoint an endowment committee and the undersigned have been asked to serve in that capacity. The work will be taken up and plans formulated so that more information will be available on this subject by the time of the next annual meeting. It is hoped that every member of the Association will cooperate in assisting the committee in this work.

A. F. BURGESS, *Chairman*
J. G. SANDERS
G. A. DEAN

INSECT PESTS OF SUGAR CANE CONSIDERED AT THE HAVANA MEETING OF THE INTERNATIONAL SOCIETY OF SUGAR CANE TECHNOLOGISTS

The Second Triennial Convention of the International Society of Sugar Cane Technologists was held in Havana, Cuba, during the week of March 14th, 1927. The sessions of the convention were divided under six main technical sections, one of which referred to insects of sugar cane. Mr. H. P. Agee, Director of the Hawaiian Sugar Planters' Association Experiment Station, Honolulu, was General Chairman, while Mr. D. L. Van Dine, Local Director of the Cuba Sugar Club Experiment Station, Tropical Plant Research Foundation, was Secretary of the Proceedings.

The following entomologists were present: B. T. Barreto of Cuba, S. C. Bruner of Cuba, W. E. Hinds of Louisiana, T. E. Holloway of Louisiana, H. T. Osborn of Mexico, H. K. Plank of Cuba, A. H. Rosenfeld of Louisiana, C. F. Stahl of Cuba, D. L. Van Dine of Cuba, and C. E. Woolman of Louisiana.

By prearrangement among the entomologists present, the time given to the section on insect pests of sugar cane (including the utilization of parasites) was devoted to a discussion of borers of sugar cane and the general subject of parasite introduction.

The first session on insects was held on Tuesday afternoon, March 15th. The writer was asked to open the subject of sugar cane borers with a talk on the moth borer of Louisiana and elsewhere. The statement of the writer and the discussion which followed covered the damage, the loss, seasonal abundance and measures of control, with mention of the many factors which influence infestation. Those who took part in the discussion were Dr. Jacob Jeswiet of Java, Dr. Ph. Van Harreveld of the Netherlands, Mr. A. H. Rosenfeld of Louisiana, Dr. Julius Matz of Porto Rico, Dr. W. E. Hinds of Louisiana, Mr. W. G. Taggart of Louisiana, Mr. R. Menendez Ramos of Cuba, Mr. F. A. Lopez Dominguez of Porto Rico, Mr. H. P. Agee of Hawaii, Mr. H. H. Storey of South Africa, Mr. H. F. Clarke of Fiji, Mr. H. T. Osborn of Mexico, Mr. W. T. Seymour-Howe of Queensland, Mr. G. M. Fortun of Cuba, Mr. B. T. Barreto of Cuba, Mr. H. K. Plank of Cuba, Mr. S. C. Munson of Louisiana, Mr. C. D. Kemper of Louisiana, Mr. F. S. Earle of Cuba, and Mr. C. E. Woolman of Louisiana.

Under measures of direct control, Dr. W. E. Hinds and Mr. H. K. Plank reported results obtained with various chemicals. Mr. C. E. Woolman showed a motion picture of the application of poison dust to cotton by airplane, and Dr. Hinds showed lantern slides of the application to sugar cane.

The second meeting of the insect session was held on Thursday afternoon, March 17th. Mr. H. P. Agee, of the Hawaiian Sugar Planters' Association Experiment Station told in considerable detail of the many explorations which have been made by the Hawaiian entomologists for parasites of the insect pest of sugar cane. He brought out the fact that three major cane insects have been brought under control by this method. Mr. Agee pointed out that many parasites for pests other than those of sugar cane have also been introduced into Hawaii by the entomologists of the sugar planters' station. He emphasized the persistence with which the work has been carried on, and the fact that after long years of effort, failure or only partial success has been turned into complete success.

In the discussion of the subject of parasites, it was suggested that perhaps Hawaii is especially favorably situated in climate and isolation for the success of work of this character. Mr. Agee stated that much of the work would doubtless have failed if the entomologists had not gone ahead year after year with great confidence in their

work and with equal confidence on the part of the sugar planters back of them. Mr. Van Dine reminded the members that the Hawaiian work was inspired by the success of Mr. Albert Koebele, who very early introduced the natural enemy of the cottony cushion scale into California from Australia, an example of bringing and establishing a beneficial insect from one continental area to another and under climatic conditions less favorable than those of Hawaii.

The discussion then centered around a plan presented by Mr. Rosenfeld for Mr. Harold E. Box of Argentina, who proposed international cooperation in the matter of exploration for parasites of sugar cane insects. This idea was supported by Mr. J. T. Crawley and Dr. Julius Matz. Mr. Van Dine, as chairman of the section on insects, suggested that a committee be proposed to consider the question and that the Society in general session be requested to act. The action of the Society was to accept the idea of such a committee, which was formed with the following members: A. H. Rosenfeld, Louisiana, Chairman,; J. T. Crawley, Cuba; J. Matz, Porto Rico. The special subject for this committee is cooperative exploration for parasites of sugar cane insects.

In the general session it was brought out that a regular standing committee should be appointed for each section, thus providing for a means of compiling and distributing information between conventions. In accordance with the resolutions adopted, the following Committee on Insect Pests of Sugar Cane (Including Biological Control) was appointed: F. Muir, Hawaii, Chairman; T. E. Holloway, Louisiana; Dr. Hazelhoff, Java; Masato Ishida, Formosa; H. T. Osborn, Mexico; D. L. Van Dine, Cuba.

An entomological subject which was on the program of the section on plant pathology was a consideration of the insect transmission of the sugar cane mosaic disease, by Mr. C. F. Stahl, of the Tropical Plant Research Foundation. Mr. Stahl told of his work in Cuba with the corn aphis, the only known vector.

It was the unanimous opinion that the sessions of the convention were of extraordinary interest and value. Besides the meetings, an excursion was provided to Central Hershey, a large sugar factory thirty miles from Havana by electric railroad, and to the Agricultural Experiment Station of the Cuban Government at Santiago de las Vegas.

On Sunday night, March 20th, the visiting members of the Society boarded a special train of Pullman cars provided by the Government, and a week's tour of the island was made as guests of the Republic of Cuba.

A number of the large estates and sugar factories were visited and special examination was made of the work of the Cuba Sugar Club Experiment Station of the Tropical Plant Research Foundation at Centrals Baragua and Jarónu.

At the final session of the convention Java was selected as the next meeting place, the time being in the early fall of 1929. Dr. Jacob Jeswiet of Java was elected General Chairman for the Java meeting and Mr. D. L. Van Dine of Cuba as General Secretary.

T. E. HOLLOWAY, *Bureau of Entomology*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1927

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

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The Editor invested a nickel in a popular weekly with a circulation of over two million and six hundred thousand. The cover illustration depicts wonder and very naturally suggests the query: Is there a limit? The most interesting feature to an entomologist is the story of: "The Battle of the European Corn Borer." It is a very successful example of publicity, undoubtedly facilitated by the ten million dollars expended, one fourth for equipment such as 1240 tractors, 800 stubble pulverizers, as many covering plows, 64 field burners, 100 3½ ton trucks, 75 1-ton trucks, 74 stalk-pile burner rigs, 100 busses for scavenging crews, 64 tank trailers for field burners, 15 1000-gallon tank trucks, 50 600-gallon tank trucks, 475 slip-on-body ½ ton trucks and 75 small coupes. It reads like equipment for an army, and it is. The organization was evidently based on methods learned in the World War. The story itself is of more than passing interest. It is intelligible to the man on the street. It brings out the important points. Certain phases may have been somewhat over-stated in the judgment of the cold, calculating scientist. Broadly speaking the facts justify much that was written. It is one of the outstanding examples of publicity in economic entomology and as such entomologists are urged to invest a nickel in the issue of the Saturday Evening Post for July 16, 1927 and study both the cover illustration and the article on the European Corn Borer. The question is bound to arise: Is there a limit? Certainly no entomological bulletin or report as we know such documents would be issued in any such edition. Economic entomology, especially large-

scale control work, has developed enormously—much beyond what many entomologists realize and the end has not been reached. Perplexing questions as to policies are ever present. The recent clean-up of corn borer territory has been a very effective demonstration of mobilization possibilities. The material welfare of the country is dependent to a very considerable extent upon control of insect pests. Quarantines are enforced to prevent spread. The government and states have combined forces for the reduction of a general corn borer infestation. This latter is but an extension of quarantine, and quite possibly a very economical method of restricting spread. It is a new development deserving careful study.

Obituary

RALPH INGRAM SMITH

RALPH INGRAM SMITH was born at Leverett, Massachusetts, September 16, 1882, and died February 26, 1927, at Boston, Massachusetts, as the result of a combined attack of pleurisy and grippe.

He was graduated from the Massachusetts Agricultural College in 1901 and shortly thereafter accepted a position as Assistant Entomologist at the Maryland Agricultural College, serving in that capacity until July 1903. In August of that year, he was appointed Assistant Entomologist to the Georgia State Board of Entomology, and in 1905, was made Entomologist to that Board. In 1907, he was appointed Entomologist to the North Carolina Agricultural and Mechanical College and Experiment Station, and served in that capacity until December 1911. Early in 1912 he was appointed Professor of Entomology at the College of Agriculture and Mechanical Arts, Porto Rico. From 1915, until the time of his death, he was in charge of the activities of the Federal Horticultural Board, United States Department of Agriculture, in the port of Boston. Mr. Smith was the author of a number of publications relating to economic entomology.

He was a member of the American Association for the Advancement of Science, the Entomological Society of America, and the Association of Economic Entomologists.

The experience gained by Mr. Smith in his early entomological work peculiarly fitted him for the position in Boston, which he filled with credit to himself and the Board he represented. He was ever mindful of the necessity of protecting this country from invasion by injurious insects and plant diseases, and during his service in Boston he was

responsible for a number of very important interceptions. Along with his firmness, however, there was a human strain which made it possible for him to see the problem from all angles, which resulted in his having a host of friends among the importers and his associates in other branches of the Government service. He was a man of splendid character, a staunch and loyal friend, devoted to his home and family, and highly appreciated in the community in which he lived. In his untimely death, the Federal Horticultural Board, as well as his associates and co-workers, have suffered a distinct loss.

E. R. S.

Review

Manual of Forest Insects, by H. B. PEIRSON, Main Forest Service, Augusta, Maine. Bulletin No. 5, pp. 1–130, 1927.

This new bulletin by Mr. Peirson supplies the information on forest insects of economic importance which has been greatly needed by the forest worker of New England. The arrangement of subject matter whereby the insects attacking each species of forest tree are listed as a group, is of éspecial interest and use to the field worker while the lists of "Other Insects," which includes those species sometimes found attacking the forest tree species concerned, will be particularly useful in identifying the unusual cases which are encountered in the forest. It is as a handy manual for field use in the identification of insects and insect injuries by the workers relatively inexpert in Entomology that this bulletin will attain its greatest use, although the arrangement of the bulletin, the attention paid to description, particularly to that of the injury caused by the insect concerned, and the fact that but little has been written on this subject and compiled in a handy volume will make this bulletin one of use to all interested in forest insects.

As intimated by the author in his introduction, the control of forest insects still consists of simple measures and is relatively undeveloped. The lack of specific control recommendations in this, as in practically all bulletins concerned with forest insects, is to be taken as an indication of opportunity for future work and not as a weakness of the bulletin.

This publication is indicative throughout of careful and detailed work and can be extremely useful in spreading a knowledge of the forest insects of economic importanc.

K. A. SALMAN

Current Notes

Mr. A. G. Dustan recently gave a talk on garden insects and their control at the annual banquet of the Ottawa Horticultural Society.

Dr. Roger B. Friend, Assistant Entomologist of the Connecticut Agricultural Experiment Station, received the degree of doctor of philosophy from Yale University on June 22.

R L Smith

J. M. Aldrich, of the U. S. National Museum, is collecting Diptera this summer through a half-dozen states west of the Great Plains.

Professor H. C. Fall of Tyngsboro, Mass., visited the Division of Insects, U. S. National Museum from May 24 to May 27, studying types in the Casey Collection of Coleoptera.

Dr. B. A. Porter of Vincennes, Ind., visited the Japanese Beetle Laboratory, Riverton, N. J., on May 26 and conferred with E. R. Van Leeuwen relative to codling moth investigations.

Dr. S. Hadwen, of the University of Saskatchewan, visited Ottawa on May 10 and spent some time discussing matters of entomological interest with the Dominion Entomologist.

The Kansas Entomological Society held a field meeting on July 3 and 4 at the Sand Hills, Medora, Kansas. Many interesting insects were collected on this trip.

According to *Science*, Professor William Morton Wheeler, Dean of Bussey Institution of Harvard University, has been awarded the Dollfus prize of the French Entomological Society.

Mr. Harvey L. Sweetman resigned his assistantship in entomology at the University of Minnesota, April 1, 1927, to accept a position with State Entomologist C. L. Corkins of Wyoming.

Dr. Stanley C. Ball, formerly curator of collections, Bishop Museum, Honolulu, has resigned to accept a position as curator of zoology at Peabody Museum, Yale University.

At the recent commencement of the University of Illinois, the degree of Doctor of Philosophy in Entomology was conferred upon Messrs. M. R. Smith and R. M. DeCoursey.

Mr. M. R. Smith spent several weeks during June obtaining records for the Illinois State Natural History Survey of the Illinois Lepidoptera in the Barnes Collection at Decatur.

An office has been opened at 682 Main Street, Stamford, Conn., for the enforcement of the quarantine against the Japanese beetle, State and Federal forces coöperating.

According to *Science*, Dr. George H. F. Nuttall, Professor of Parasitology in the University of Cambridge, has been made Professor *honoris causa*, in the University of Strasbourg.

According to *Science*, Dr. R. J. Tillyard, Chief of the Biological Department, Cawthron Institute, Nelson, New Zealand, has been elected an honorary member of the Entomological Society of Belgium.

Science reports that the honorary degree of doctor of science has recently been conferred by the University of Pittsburgh upon Hugo Kahl, Curator of Entomology in Carnegie Museum.

Messrs. S. S. Crossman, C. W. Collins, and D. F. Barnes of the Federal gipsy moth forces, visited Albany, New York, in April, where they conferred with Dr. E. P. Felt and Mr. H. L. McIntyre.

Mr. A. F. Burgess gave a fifteen-minute talk on "The Gipsy Moth," as part of the Burgess Radio Nature League program, from the Westinghouse Radio Station WBZ on March 30.

Mr. Herbert L. Parten, a graduate of the University of Minnesota, and at present a graduate student at that institution, has been appointed Extension Entomologist at the University of Minnesota.

President R. W. Harned attended the meetings of the Western Plant Quarantine Board and the Pacific Slope Branch at Reno, Nevada, June 20 to 24, and afterward visited a number of stations in California.

Mr. F. G. Holdaway from Australia, who has been studying at Cornell University, has recently visited several state and Federal entomological laboratories and field stations in the eastern United States.

At the annual meeting of the Entomological Club of Southern California, held in Alhambra, June 17, the following officers were elected: H. J. Ryan, President; George P. Weldon, Vice-President, and C. K. Fisher, Secretary-Treasurer.

According to *Science*, Professor E. W. Stafford, of the Mississippi Agricultural and Mechanical College, will offer the summer work in elementary and advanced entomology at the summer session of the University of Minnesota.

The following transfers in the Bureau of Entomology have been announced: Ralph A. Blanchard, from Monroe, Michigan, to Tempe, Arizona; H. C. Hallock, Riverton, New Jersey, to Westbury, Long Island; Dr. N. E. McIndoo, Washington, D. C., to Sligo, Maryland.

Mr. Edwin H. Bryan Jr., formerly entomologist on the staff of Bishop Museum, Honolulu, has been appointed curator of collections *vice* Dr. Stanley C. Ball, who resigned to accept a similar position at Peabody Museum, Yale University.

According to *Science*, Mr. R. H. Bell, formerly Assistant Director of Agricultural Extension Work at State College, has been appointed Director of the Bureau of Plant Industry, Pennsylvania Department of Agriculture *vice* C. H. Hadley, who resigned May 1.

Dr. C. H. Kennedy, of Ohio State University, visited the Japanese Beetle Laboratory the last week in May. Dr. Kennedy has arranged for the transfer of the Wenzel Collection of Coleoptera from Philadelphia to Columbus, Ohio.

European corn borer parasite importations by the Bureau of Entomology this spring are as follows: 160,970 *Microgaster* cocoons; 33,831 *Eulimneria* cocoons; 1,661,590 corn borer larvae, from which five additional species will be reared at Arlington, Mass.

Mr. T. R. Gardner, who left Riverton, N. J., early in May, has arrived at his station in Yokohama, Japan. He will continue collecting *Popillia* parasites in Japan, in Chosen, and, so far as conditions permit, in China.

Dr. W. P. Hayes, Assistant Professor of Entomology, Illinois University, is with the Department of Entomology, Kansas State Agricultural College, this summer helping with the inspection and certification of flour mills which are exporting flour to Europe.

Mr. S. A. Rohwer has been appointed business manager of the Bureau of Entomology in addition to his duties as head of the Taxonomic Division of the U.S. National Museum. Mr. E. B. O'Leary has been appointed Administrative Assistant.

According to *Science*, Miss Edith W. Mank, Lawrence, Mass., has been awarded a second prize by the Boston Society of Natural History, for a manuscript entitled "The Life History of *Baris scolopacea* Germ." This is one of the Walker prizes.

Dr. J. M. Swaine, Entomological Branch, attended a European corn borer conference at Chatham, Ontario, in the latter part of April, and later proceeded to Amherst, Mass., to attend a conference on the white pine weevil with United States officials.

According to *Science*, the collection of Lepidoptera made many years ago by the late Henry F. Schoenborn of Washington, D. C., has been presented to the U. S. National Museum by his daughter, Miss Theresa F., and his son, William E. Schoenborn.

Miss Irene D. Dobroscky, Assistant Entomologist of the Boyce Thompson Institute for Plant Research, sailed July 6 on the S. S. Tuscania for Plymouth, England. Miss Dobroscky expects to spend three months in Europe and will attend the Zoölogical Congress at Budapest.

Mr. Stanley Garthside, who for the past college year has been attending Cornell University on a scholarship in Forest Entomology from Australia, has been visiting some of the state and Federal entomological laboratories and field stations in the eastern United States.

Dr. Alfons Dampf, Chief Entomologist, and Senor Copel Rivas, Quarantine Officer, of the Mexican Department of Agriculture, en route to the meetings of the Western Plant Quarantine Board meetings at Reno, Nevada, visited a number of Western laboratories and consulted the entomologists and quarantine officers.

The following entomologists recently visited the Boyce Thompson Institute for Plant Research: Mr. Herbert T. Osborn of the United Sugar Company, Las Mochis, Sinaloa, Mexico; Dr. Grace H. Griswold of Cornell University, Ithaca, N. Y.; Mr. D. J. Caffrey and Mr. C. H. Batchelder of the European Corn Borer Laboratory, Arlington, Mass.

Dr. H. W. Allen, of the Japanese Beetle Laboratory, Riverton, N. J., recently visited the Gipsy Moth Laboratory, Melrose Highlands, Mass., and the Corn Borer Laboratory, Arlington, Mass., and on May 17, called at the Connecticut Agricultural Experiment Station, New Haven, Conn., to examine type material in the genus *Tiphia*.

Professor R. A. Wardle of the University of Manchester, England, arrived in the United States recently and took up his work as Associate Professor of Entomology at the University of Minnesota on July 1. Professor Wardle is well known as a co-author of "Principles of Economic Entomology," by Wardle and Buckle.

According to *Science*, the tenth annual meeting of the Northwestern Association of Horticulturists, Entomologists and Plant Pathologists was scheduled to be held at the University of Idaho, Moscow, Idaho, and at the State College of Washington, Pullman, Washington, on June 27, 28, and 29. These two institutions are only nine miles apart.

Professor A. L. Melander, of the College of the City of New York, Mrs. Melander, Professor C. T. Brues, of the Bussey Institute, and Mrs. Brues, visited the Gipsy Moth and Corn Borer Laboratories in April. L. G. Baumhofer, of the Division of Forest Insects, also stopped at the Gipsy Moth Laboratory recently.

The Department of Entomology of the Kansas State Agricultural College has been allotted two acres of ground for experimental work. A two-room house on the ground has been remodeled into a field office and laboratory. A large field insectary has been built and a new cave for the rearing of subterranean insects has been constructed.

Dr. Clarence E. Mickel of the Division of Entomology and Economic Zoölogy at the University of Minnesota, has resigned his position as Extension Entomologist which he has held for the past five years. Beginning July 1, Dr. Mickel will have charge of the insect collections and will teach the courses in general and systematic entomology in the Department of Zoology.

A newspaper dispatch from Danbury, Conn., dated June 22, states that Nicholas Soloman of that city has established a silkworm farm, having brought 20,000 eggs from Syria, his native land, last fall. These he has successfully hatched, and the worms are now nearing the productive period. Mr. Soloman's only difficulty in his novel enterprise has been in finding sufficient mulberry leaves for the worms' diet.

Recent appointments in the Bureau of Entomology are announced as follows: Herbert H. Schwardt, Bentonville, Ark.; Lawrence C. McAlister Jr., Riverton, N. J.; Dean L. Christenson, Salt Lake City, Utah; Glenn C. Barrett, Wichita, Kansas; D. L. Van Dine Jr., Jaronu, Cuba; Charles A. Clark, Arlington, Mass.; Earl G. Davis, Tempe, Ariz.; Howard O. French, Salt Lake City, Utah; J. K. Holloway, M. C. Swingle, E. T. Lundberg, R. W. Burrell, and Max R. Osburn, Riverton, N. J.; Harold H. Shepard, Washington, D. C.; A. Weed, Madison, Wis.

Mr. H. J. MacAloney, of the Harvard Forest Reserve, Amherst, Mass., is spending two months this summer with the Division of Forest Insects, Entomological Branch, coördinating the Branch work on the white pine weevil with the extension investigations being carried out under his direction in the eastern United States. Mr. MacAloney was recently at Fredericton, N. B., and will later continue working in Nova Scotia, Quebec, and Ontario.

According to *Science*, the program of the twelfth assembly of the Czechoslovak Academy of Agriculture, held at Prague on June 11, included a celebration of the seventieth birthday of Dr. L. O. Howard, Chief of the Bureau of Entomology of the U. S. Department of Agriculture. The address was made by Dr. Frantisek Rambonsek, who referred to Dr. Howard's successful activities for the benefit of the agriculture of the whole world.

Dr. R. N. Chapman, Chief of the Division of Entomology and Economic Zoölogy at the University of Minnesota, who is spending his sabbatical year in Europe studying biotic potential, attended the meetings of the French Association for the Advancement of Science at Constantine, North Africa. After the meetings he went on an excursion with the French scientists some one hundred miles into the Sahara Desert, returning by way of Tunis.

Mr. C. H. Curran, of the Entomological Branch, Department of Agriculture, Ottawa, Canada, spent two weeks in April in Washington studying flies in the

National Collection, and collecting in the vicinity of the District. He returned to Canada on April 29. While here, besides consulting with the specialists in the National Museum, he conferred with other members of the Bureau, especially those in the Division of Stored-Product Insect Investigations.

In the interests of Insect Pest Survey work, Mr. J. A. Hyslop made a trip to the Pacific Coast during June, giving talks at the meetings of the Entomological Club of Southern California and the Pacific Slope Branch, at Reno, Nevada. Work on the determination of the actual field population of the alfalfa weevil was carried on at Salt Lake, and of the pepper weevil in Orange County, California.

Dr. S. P. Minkiewicz, Entomologist, Department of Entomology of the Government Institute for Agricultural Research, Bulawly, Poland, visited the Branch headquarters early in May and spent many days conferring with Branch officers. Dr. Minkiewicz is visiting centers of entomological research in various parts of the United States and Canada, securing data on their organization, methods of study, etc. He is chiefly interested in economic entomology, particularly in fruit and field crop investigations.

Recent temporary appointments in the Entomological Branch, Canadian Department of Agriculture, are as follows: W. E. Steenburgh, George Wishart, Chatham, Ont.; R. M. White, Treesbank, Man.; Ellis McMillan, A. P. Arnason, Saskatoon, Sask.; A. C. Pierce, Lethbridge, Alta.; H. H. Ross, Agassiz, B. C.; J. Stanley, Victoria, B. C.; F. Jeffrey, Ottawa; H. B. Stevens, Chatham, Ont.; B. D. Blair, Niagara Falls, Ont.; J. B. Maltais, Hemmingford, Quebec; D. G. Gillespie, Vernon, B. C.; Ernest A. Rendell, Trinity Valley, B. C.; J. R. B. Coleman, Fredericton, N. B.; R. Paradis, Ottawa.

According to the newspapers, Warran Knaus, Editor of the Democrat-Opinion, and Coleopterist, has received the degree of doctor of science from his alma mater, the Kansas State Agricultural College and from McPherson College. Dr. Knaus has a collection of more than 100,000 specimens representing more than 10,000 species of beetles. He is credited with the discovery of at least 100 new species, twenty of which have been named in his honor.

Mr. J. C. Bridwell, who has been in the Orient for the last few years, has returned to America, and visited the Division of Insects on April 29 and 30. Mr. Bridwell brought with him many specimens which he has collected, and has arranged to have forwarded a considerable series of specimens from India. He is primarily interested in completing his studies on Bruchidae (Mylabridae) and is making an effort to find means for continuing them.

On March 23, Oliver I. Snapp gave an address at Clemson College, S. C., on "Insects Attacking the Peach in the South and How to Control Them." Mr. Snapp states that the plum curculio infestation in the Georgia Peach Belt has again become serious. The present infestation is apparently the heaviest that has occurred there in five years. Five bushels of peach drops collected on April 11 have already given up 4,481 curculio larvae.

Mr. A. R. Prince has been appointed Biologist and will have charge of the work in entomology and plant pathology at the Agricultural College, Truro, N. S., in place of Dr. W. H. Brittain, who resigned to become Professor of Entomology at MacDonald College, McGill University. Mr. Prince took his undergraduate work at Acadia

University, Wolfville, N. S., and graduate work in mycology, plant pathology and entomology at Harvard University, and expects to receive a doctor's degree at an early date.

On May 8, Messrs. William Middleton and T. E. Snyder, of the Bureau of Entomology, inspected coniferous timbers recently removed from the roof of the White House. The roof has been so greatly weakened that it had to be replaced. It was found that the timbers of the roof had been powderposted by a Cossonid, ***Hexarthrum ulkei*** Horn. This insect has caused similar injury to buildings in New York and Washington, and has also damaged flooring in houses in Washington.

Messrs. J. L. King and H. W. Allen, of the Japanese Beetle Laboratory, Riverton, N. J., recently visited the Gipsy Moth Laboratory at Melrose Highlands, and the Corn Borer Laboratory at Arlington, Mass. While there they made a profitable study of the methods used in parasite work at these institutions. Dr. Allen spent a few hours examining type material of North American *Tiphia* in the collections of the Cambridge Museum of Cooperative Zoology, as well as in the Connecticut State collection at New Haven.

Mr. H. G. Crawford, Entomological Branch, visited southwestern Ontario and certain corn borer infested sections of the United States from May 28 to June 8, to survey the progress of the corn borer "clean-up" control operations. He motored some five hundred miles through the counties of Norfolk, Oxford, Elgin, Kent, Essex, Lambton, and Middlesex in company with Professor L. Caesar, Provincial Entomologist. His visit to the United States consisted of a three hundred mile tour through western Ohio, and south completely across the infested area, in company with Mr. G. M. Stirrett.

A radio talk entitled "Insect Pests of Haiti," was given in French by Augustin Fabius, and in English by George N. Wolcott, from Station HHK, Port-au-Prince, Haiti, on the evening of June 10, 1927. The almost complete absence of insect pests attacking coffee and logwood, the first and third most valuable export crops, and the practical immunity of the native Haitian cotton from attack by the pink bollworm were the main points emphasized. Sisal, which has recently been extensively planted, is also free from attacks by specific pests. Bananas and sweet potatoes, widely grown for domestic consumption, are, however, seriously injured by *Cosmopolites sordidus* Germar and *Cylas formicarius* F.

Messrs. A. F. Burgess, H. L. Blaisdell, and J N. Summers of the Bureau of Entomology spent several days in the week of April 25 investigating gipsy moth conditions in the barrier zone and in bordering towns. By previous arrangement Harold L. Bailey, Entomologist of the Vermont Department of Agriculture, was met at Brattleboro, and several bad infestations east of the barrier zone were inspected and arrangements completed for conducting coöperative control work to prevent spread from these colonies. In the course of the trip a conference was held at Rouses Point, N. Y., with Messrs. L. S. McLaine and S. H. Short, of the Entomological Branch, Department of Agriculture, Ottawa, Canada, and the work in the barrier zone and in the Canadian territory was thoroughly discussed.

Professor C. W. Howard, who for the past ten years has been working in the upbuilding of the silk industry of Southern China, is returning from Canton to this country as Head of the Department of Biology at Wheaton College, Wheaton,

Illinois. Beginning his work in the Biology Department of the Canton Christian College, Professor Howard developed the work in Sericulture to such an extent that the Chinese government established the Kwongtung Provincial Bureau for the Improvement of Sericulture under his directorship. In response to the urging of the government officials, he will retain his connection with this work, returning to Canton for summers for the next few years.

Dr. W. E. Britton, John T. Ashworth, and Commissioners E. F. Hall and W. A. Hendrick of Connecticut, visited Bristol County, Massachusetts, on July 12, to view the woodlands defoliated by the gipsy moth. Mr. C. W. Collins of the Gipsy Moth Laboratory, Melrose Highlands, Mass., met the party at Taunton and showed them some of the Federal experimental work. On the same day Mr. Harry B. Weiss with a party from New Jersey visited the same area and were shown about by Mr. S. S. Crossman of the Gipsy Moth Laboratory. In the territory between Taunton, New Bedford and Fall River there are thousands of acres where the woodland is stripped of foliage, some of it appearing as bare as in winter.

The California Spray Chemical Company is financing a scholarship at the Kansas State Agricultural College for the coming year for the testing of "Volck" as an insecticide for certain external parasites of domestic animals. This project is linked up with the Crop Protection Institute, and will be carried through as one of their regular projects. The committee in charge of the work consists of Prof. Roger C. Smith as chairman, Prof. Geo. A. Dean and Dr. E. J. Frick of Kansas State Agricultural College, Dr. F. C. Bishopp of the Bureau of Entomology, and Prof. W. C. O'Kane of Durham, N. H. Mr. Wesley G. Bruce, a graduate of Kansas State Agricultural College with the class of 1920, was selected to carry on this project, and reported to begin the work on June 1st.

An important Oriental peach moth meeting with representatives of canning companies was held at St. Catharines, Ontario, on May 17, Mr. Gibson, the Dominion Entomologist, being in the chair. This meeting was called to arrange for a definite understanding as a result of which boxes and other containers used for peaches would be sterilized before being returned to the growers. Other officers of the Department present at the meeting were: Mr. L. S. McLaine, Chief of the Division of Foreign Pests Suppression, Mr. W. A. Ross, in charge of the Vineland, Ont. laboratory, Mr. R. W. Sheppard, in charge of the Oriental peach moth scouting work, and Mr. C. S. McGillivray of the Division of Meat and Canned Foods of the Health of Animals Branch. Following this meeting, Mr. Gibson, in company with Mr. L. S. McLaine and Dr. S. P. Minkiewicz of Poland, proceeded to Toledo, Ohio, to see some of the results of the clean-up work of the European corn borer. Leaving Ohio, a visit en route was also paid to the Monroe, Michigan, corn borer parasite laboratory, and from Windsor, Ontario, a trip through the area under provincial clean-up regulations was made as far as Chatham. The parasite work at Chatham was looked into and on the following day a brief visit was paid to the Strathroy, Ont., Laboratory and the Western University at London, Ont. On the Saturday following, the Plant Inspection Office at Toronto was visited.

Apicultural Notes

The Arkansas Valley Beekeepers' Association met at Wichita, Kansas, July 26.

Starting at Kaukauna, a bee tour will be held across the state of Wisconsin the week beginning August 15.

Professor Lloyd M. Bertholf has just been given a temporary appointment to return to the Bee Culture Laboratory of the Bureau of Entomology to continue his experiments on the response of the honeybee to lights of various intensities and wave lengths.

Although U. S. standard grades for honey have just been published in Department Circular 410 of the United States Department of Agriculture, reports have been received that use is already being made of them by certain large commercial shippers of honey.

Miss Mary Louise Crossman has been appointed temporary field assistant of the Bee Culture Laboratory, Bureau of Entomology, to assist in bee disease research and in the diagnoses of samples of bee diseases which are sent to the Laboratory from all parts of the country.

The Alabama Beekeepers Association will meet on August 4 and 5 at Auburn, Alabama. Mr. George S. Demuth of *Gleanings in Bee Culture*, will be one of the principal out-of-state speakers, and any visiting beekeepers from any part of the United States will be cordially welcomed at the meetings.

The facilities for research work at the Bee Culture Laboratory, of the Bureau of Entomology, have been considerably augmented by the addition of an entire new bee disease laboratory on the third floor of the present building where diseases pertaining to both brood and adult bees will be studied.

A cabin has been leased in an isolated locality about sixteen miles from Laramie, Wyoming, to serve as temporary headquarters for some flight activity and bee disease work. Mr. W. C. Northrup and Mr. C. Harry Linsley have received temporary appointments as field assistants to assist in this work at the Intermountain Bee Culture Field Station of the Bureau of Entomology.

Two large interstate beekeeping meetings will be held in the Middle West during July and August, one at Omaha and Council Bluffs on July 12 and 13. The first day of the meeting will be held at Omaha; the second day in Council Bluffs, which is just across the river. A great many beekeepers in the immediate surrounding states are expected to attend these meetings.

The second interstate meeting will be held on August 9, 10, and 11 at Hamilton, Illinois. Inasmuch as an excellent program is being arranged, and a great many beekeepers will have the privilege of visiting the manufacturing plant of Dadant and Sons, one of the leading manufacturers of beekeeping supplies in the United States, this meeting will probably be well attended.

A beekeepers' meeting will be held in connection with Farmers' Week in Gainesville, Florida, the second week in August. At this meeting Mr. Harry Laidlaw will give a demonstration of artificial mating of queen bees. This demonstration should be extremely interesting in view of the fact that Mr. Laidlaw has had considerable success in the artificial mating of queen bees without the use of instruments. He is associated in this work with Mr. Charles W. Quinn, the veteran queen-breeder.

Horticultural Inspection Notes

The Western Plant Quarantine Board held its ninth annual conference at Reno, Nevada, on June 21 and 22. A report of the meeting has not yet been received.

Mr. N. Rex Hunt has been placed in charge of the Import Division of the Federal Horticultural Board, taking over the duties of Mr. R. K. Beattie, who has been transferred to the Bureau of Plant Industry.

Dr. R. W. Leiby, of the North Carolina State College of Agriculture, made a brief visit to Washington recently to confer with members of the Federal Horticultural Board relative to the enforcement of the Domestic Narcissus Bulb Quarantine.

Mr. George Becker, in charge of the pink bollworm eradication work of the Federal Horticultural Board, was in Washington during the week of June 20, for a conference relative to further work on the pink bollworm and the Thurberia weevil.

Mr. James Zetek, who has charge of the horticultural inspection in the Canal Zone, has been temporarily transferred to Brownsville, Texas, to assist in the clean-up work being carried on in that region in an attempt to eradicate the Mexican fruit fly.

Mr. Noel F. Thompson, who was formerly employed by the U. S. Department of Agriculture, Office of Cereal Crops and Diseases of the Bureau of Plant Industry, has been appointed associate plant pathologist of Wisconsin. Mr. Thompson will be in charge of the bulb and raspberry inspection.

Dr. S. B. Fracker, State Entomologist of Wisconsin, resigned his position with that state to accept an appointment with the Federal Horticultural Board as Senior Plant Quarantine Administrator. He reported in Washington for duty on June 16 to take charge of the enforcement of domestic quarantines.

The funds of the Minnesota State Nursery Inspection Service have been increased from $8,000 to $10,000 per annum. At the same time the fees for inspection have been increased so that the general nursery pays $25, the small fruit grower selling stock, $15, and those selling only raspberries and evergreens, $10 per annum.

Mr. C. E. Cooley, who is in charge of the work of the Federal Horticultural Board in Porto Rico, was in Washington for a few days recently for a conference relative to his work on the Island. Mr. Carlos Chardon, Commissioner of Agriculture of Porto Rico, was also in Washington at the same time to discuss quarantine and inspection problems.

Mr. E. L. Chambers, who was at one time employed in the Bureau of Entomology, has been selected to fill the position of state entomologist and plant pathologist of Wisconsin recently vacated by the resignation of Dr. S. B. Fracker. Mr. Chambers will have charge of the plant quarantine work for the State, as well as the work on entomology and pathology.

A public hearing was held by the Federal Horticultural Board in Washington on June 20, relative to the recent outbreak of the Mexican fruit fly, *Anastrepha ludens*, Loew, in the delta region of the Rio Grande River. The states of Texas, California, and Florida were well represented at the hearing. Among those present were Messrs. R. E. McDonald and J. M. Del Curto of Texas, Lee A. Strong of California, and J. H. Montgomery of Florida.

At a conference held at the Department of Agriculture on June 22 to consider the necessity of placing restrictions on the movement of green corn within the area now quarantined on account of the European corn borer, it was decided that such action is not warranted at the present time. The conference was called and presided over by Dr. C. L. Marlatt, Chairman of the Federal Horticultural Board. Opportunity was given for those present to state their views on the subject, and communications from interested persons not present were read and discussed. After a thorough consideration of the various points of view, it was deemed unnecessary, at the present time, to place any restrictions on the movement of green corn within the quarantined area.

Notes on Medical Entomology

Mr. W. E. Dove, who resigned from the Bureau of Entomology last October to pursue graduate studies at John Hopkins University, was reappointed in the Bureau of Entomology on June 1. He will continue investigational work on insects which affect livestock, with headquarters at Dallas, Texas.

Mr. H. M. Brundrett, Professor of Horticulture at John Tarleton Junior Agricultural College, Stephenville, Texas, has been appointed by the Bureau of Entomology for work at Dallas, Texas, during the summer season. He will continue investigations begun by him two years ago of sprays against flies which affect livestock.

Dr. Karl Jordan, Curator of the Tring Museum, England, spent most of the month of May at the U. S. National Museum, studying the collection of fleas. Dr. Jordan is preparing a monograph of the fleas of the world as a memorial to the late Honorable N. Charles Rothschild, who was for many years an associate of Dr. Jordan in his work on the fleas. While in Washington Dr. Jordan called on a number of scientific men whose acquaintance he had made abroad.

Largely owing to the initiative of the Dominion Entomologist, an organization known as the Mosquito Control Committee of the Ottawa District has been formed in Ottawa, and sufficient funds secured to carry on a comprehensive control campaign against local mosquitoes. The Committee, which is functioning under the chairmanship of Dr. R. E. Wodehouse, of the Canadian Tuberculosis Association, is made up of official representatives of local municipalities and Messrs. Arthur Gibson (who is acting as secretary) and C. R. Twinn, of the Entomological Branch. Oiling operations have been in progress since the end of April under the field direction of Mr. Twinn and were completed early in June. Although mosquitoes are proving a severe pest in many sections of Canada, because of the unusually extensive rains which fell during May, the residents of Ottawa and neighboring municipalities are enjoying comparative immunity as a direct and gratifying result of the control operations.

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Proceedings of the Twelfth Annual Meeting of the Pacific Slope Branch, American Association of Economic Entomologists

The 12th annual meeting of the Pacific Slope Branch was held at the University of Nevada, Reno, Nevada, June 22 and 23. Although the attendance and number of papers presented were somewhat less than usual, the meeting in general was excellent. A joint symposium with the Pacific Coast Entomological Society on the subject "Arousing Public Interest in Entomology" proved very interesting. The State entomologists, foreseeing that their string of victories over the Federal entomologists in the annual baseball game was about to be broken, refused to play and forfeited the game. The meetings closed with the entomological dinner Thursday Evening.

PART 1. BUSINESS PROCEEDINGS

The meeting was called to order by Chairman Doane at 10:15 A. M. The following were present:

Bartlett, Oscar C., Phoenix, Ariz.
Browne, A. C., Sacramento, Calif.
Campbell, Roy E., Alhambra, Calif.
Carter, Walter, Twin Falls, Idaho.
Cartwright, W. B., Sacramento, Calif.
Cassidy, T. P., Tucson, Ariz.
Cole, F. R., Santa Cruz, Calif.
Dampf, Alf., Mexico City, Mexico.
Doane, R. W., Stanford Univ., Calif.
Doten, S. B., Reno, Nevada.
Doucette, C. F., Puyallup, Wash.
Dean, M. L., Boise, Idaho.
Fisher, C. K., Alhambra, Calif.
Flanders, S. E., Saticoy, Calif.
Flebut, A. J., San Francisco, Calif.
Freeborn, Stanley B., Davis, Calif.
Harned, R. W., A. & M. College, Miss.
Hassan, A. S., Berkeley, Calif.
Herbert, Frank B., Los Gatos, Calif.
Hyslop, J. A., Washington, D. C.
Kent, H. S., State College, N. Mexico.
Lauderdale, J. L. E., Yuma, Ariz.
List, Geo. M., Fort Collins, Colo.
Morrill, A. W., Los Angeles, Calif.
Mote, Don C., Corvallis, Ore.
O'Dell, J. H., Phoenix, Ariz.
Quayle, H. J., Riverside, Calif.
Rivas, E. Coppel, Mexico City, Mex.
Smith, Ralph H., Riverside, Calif.
Snow, S. J., Salt Lake City, Utah.

Van Duzee, E. P., San Francisco, Calif.
Wilson, C. C., Sacramento, Calif.
Volck, W. H., Watsonville, Calif.
Woodworth, C. W., Berkeley, Calif.
Zschokke, Theo. C., Honolulu, T. H.

REPORT OF THE TREASURER

Balance on hand June 16, 1926		$14.69
Refund from main Association for 1926 expenses		13.40
Interest from Bank		.71
PAID OUT		
Typing, mimeographing and printing	$ 9.25	
Dues to Pacific Division, A. A. A. S.	5.00	
Envelopes, Postage, Registry, Telegrams	5.06	
	19.31	28.80
Balance on hand, June 22, 1927	9.49	
	$28.80	

Chairman Doane appointed the following committees: Nominating H. J. Quayle, C. K. Fisher, A. W. Morrill; Resolutions: Geo. M. List, S. B. Freborn; Membership: C. K. Fisher: Auditing, D. C. Mote, A. J. Fleebut, F. R. Cole.

President Harned was then called on, and expressed his pleasure on being able to attend the meetings, and getting personally acquainted with the Pacific Slope members.

FINAL BUSINESS SESSION

Chairman Doane called for the reports of the various committees. The auditing committee reported that they had examined the accounts of the treasurer, and found them correct.

The membership committee presented the following names, and recommended that they be submitted to the parent association for associate membership: C. H. Kinsley, S. J. Snow, C. H. York, G. E. Woodhams, H. B. Sheldon, and W. B. Parker.

The resolutions committee reported as follows:

Resolved, That a hearty vote of thanks be extended to the University of Nevada for providing a meeting place and accomodations for members in attendance.

The nominating committee presented the following names: Chairman, R. S. Woglum, Vice Chairman, Geo. M. List, Sec'y-Treas. Roy E. Campbell.

The reports of the committees were all accepted.

It was moved and carried that the secretary suggest to the associate editor that Pacific Slope Notes be eliminated as a separate department,

and any such news items be incorporated with the Current Notes instead.

The meeting adjourned, to meet next year with the Pacific Division, A.A.A.S. at Pomona College, Claremont, California.

PART II. PAPERS AND DISCUSSIONS

CHAIRMAN DOANE: The first paper is by Mr. F. B. Herbert.

RAPID SPRAYING VERSUS DUSTING IN THRIPS CONTROL

By FRANK B. HERBERT, *Deciduous Fruit Entomologist,*
Balfour, Guthrie & Company, San Jose, Calif.

ABSTRACT

Comparing the speed of spraying and dusting. Sprayed 20 acres of prunes in one day, which was practically as fast as dusting, and cheaper, when the cost of materials is considered.

The main argument against spraying where dust could be applied has been that the former was too slow. The writer, however, believing this to be a false statement and that spraying could be done about as fast as dusting, for such insects as the Pear Thrips (*Taeniothrips inconsequens* Uzel), determined to try to demonstrate this fact. Accordingly twenty acres of prunes were sprayed in March 1926, and forty acres in 1927, on the Bubb Ranch near Mountain View, California.

The spraying was started at noon and ten acres were sprayed in four hours that afternoon, and spray was applied to another ten acres in four hours the next morning. The 1926 demonstration proved so satisfactory in results against the Thrips, and in cost compared with dusting which was being carried on at the same time, that liquid spray only was used against the Thrips in 1927. This season forty acres were sprayed in two eight hour days with the same satisfactory results. More spraying was anticipated but the Thrips did not become numerous enough on the rest of the orchard to warrant the use of any control measures.

EQUIPMENT

The equipment used was a five-horse-power spray machine with a capacity of 15 gallons per minute at a pressure of three hundred and twenty-five pounds. To this was attached one Friend Gun with a $\frac{3}{16}$ inch aperature in the disc, discharging nearly the full capacity of the pump, probably 12 or 13 gallons. This was drawn by two horses and driven by one man while another held the gun. In 1926, the operator sat on top of the spray machine and sprayed the trees from one side as the team walked slowly by. Finding it somewhat difficult to dodge

the limbs, this season a two-wheeled trailer was attached behind the spray machine, from which the operator was able to spray with ease.

Materials

Spraying the trees from one side was found to be sufficient as the trees were just coming into blossom, with no foliage present. Two gallons per tree were used, each three hundred gallon tank covering two acres, there being seventy-six good sized fourteen year old trees per acre. Ten tanks were applied each day, in spite of the fact that the spray machine had to be driven nearly half a mile for refilling.

The material used per 100 gallons was one and one-half gallons of distillate emulsion and three-quarters of a pint of Black Leaf Forty, making a cost of one and nine-tenths cents per gallon or $2.82 per acre. The labor cost was $.40 making a total of $3.22 per acre.

Dust was being applied at the same time and the spray was applied as fast as the dust except that it took longer to fill the spray tank. Mr. Bubb was using fifty pounds of 8% Nico Dust per acre, making a cost of $8.50. Here the labor was $.15, making a total of $8.65 per acre. The cost of labor is about one-half that of spraying because only one man was used, although there was as much need for two here as when spraying. The quantity used was somewhat high, the normal amount being about thirty pounds per acre. Even with this reduction, the cost for material was practically double that of the liquid, and also less effective. Both gave a satisfactory kill, although the fumes from the spray lasted fully twice as long as those from the dust. The liquid certainly penetrated into the crevices of the buds better than the dust, and this was where the Thrips were to be found. Dusting to be effective requires still air, while spraying can be done except in very windy weather.

Possibilities

If one were to use a large capacity spray machine, throwing twenty-five gallons per minute, he would be able to spray two rows at the same time, instead of one, making the operation twice as fast, except for filling. If one or two supply wagons were used also for refilling, a tremendous acreage could be covered in a short while. The writer has seen six thousand gallons applied in one day by one of the large machines, without using a supply wagon. At the above rate this would have covered forty acres, and by the use of a supply wagon the acreage could have been increased to forty-five or fifty acres.

Even by using a supply wagon for the machine that was used in this work, the acreage could have been increased to twenty-eight or thirty

acres, or on a normal orchard where there were one hundred trees per acre, the acreage would have run to twenty-two or twenty-five acres.

Summary

From these data one would conclude that spraying for Thrips is as fast as dusting, except for the time lost in filling, which with a supply wagon, would amount to two or three minutes per acre.

Twenty acres were sprayed in one day with a medium sized spray outfit, with a possibility of forty to fifty acres with a large machine.

A large spray machine capable of handling two large guns, would spray a larger acreage per day than the average sized power driven duster.

Spraying is more effective on Pear Thrips than dusting, and less dependent upon good weather

The labor cost of spraying is somewhat higher than dusting, which, however, is more than offset by the much lower cost of spray materials.

Chairman Doane: The next paper is by H. J. Quayle.

SPRAY AND FUMIGATION COMBINATION FOR RESISTANT RED SCALE

By H. J. Quayle, *University of California, Citrus Experiment Station, Riverside, Calif.*

Abstract

Results are given of spray alone, fumigation alone, and these in combination against the red scale on citrus trees. Highest efficiency was secured when fumigation followed within a week or ten days the application of oil spray. Oil shown to absorb little if any HCN gas and an oil spray serves as a protective film to the citrus tree, rendering it less susceptible to hydrocyanic acid injury.

Fumigation with hydrocyanic acid gas has always been considered as a satisfactory control method for the red scale on citrus trees until in certain localities in California in recent years this scale has become more or less resistant to HCN gas. Certain oil sprays of recent development have given much better results than the sprays previously used, but still spraying at the present time is not entirely satisfactory because of the results on the scales as well as the effects on the tree.

A couple of years ago a grower who was spraying as well as fumigating observed that good results followed where these treatments were applied within a short interval, and since that time considerable field experience has shown that the combination treatment generally gives satisfactory results. Why this combination treatment gives better results than a double treatment of the same method, the advantage of applying

TABLE 1.—SHOWING A BLOCK OF LEMON TREES THAT HAD RECEIVED TREATMENTS AS INDICATED BELOW. THE FIGURES REPRESENT THE PERCENTAGE OF RED SCALE KILLED

Mineral Seal 2 per cent	6	100	98	65	97	82	99	100	100	99	96	97	98	97	84	98	92	100	99	94	100	99		100	86	96	94	100	30
Trees 7 to 22	5	98	100	66	90	70	97	99	94	98	99	95.5	88	96	93	84	82	99	98	97	96	86		98.5	97	92	95.5	95	26
Oronite Crys. 2 per cent	4	100	100	93	98	96.5	100	100	98.5	100	100	100	84.5	96	83	99	86.5	99	100	99	100	100	92	93	92	93	91.5	78	25
Trees 7 to 22	3	100	100	97.5	100	88.5	98.5	100	100	100	100	95	92	91	90	100	99.5	100	100	99	100	100	74	68	71	88	49	55	20
Oronite Crys. 1 per cent	2	99.5	100	97.5	87.4	97.5	100	98	98.5	96.5	95	96.7	94	92.5	80	68.5	74.5	98	90	97.5	97	97.5	91	90.5	60	83	70	69	29
Trees 7 to 22	1	100	100	98	95	97.5	98.5	100	100	100	100	97.5	59	85	74.3	83	78	90.7	51.5	76.7	68	72	25	28	22	27			
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
		Oro. crys. 2% sprayed after fumigation		Fumigation only			Fumigation after spray						Sprayed only					Fumigation after spray					Fumigation only, except row 1. Rows 5-6 sprayed after fumigation, Oronite Crystal 2 per cent.						Ck.

the spray first or vice versa, the length of the interval between treatments, the effect of the fumigation on scales not hit by the spray, and the effect of the combination treatment on the tree, are some of the questions I have attempted to answer.

A portion of a block of lemon trees severely infested with the red scale was sprayed with an oil spray. A part of these trees along with others not sprayed were later fumigated. Other trees that were fumigated only, were later sprayed. The general scheme is shown in Table 1. Trees 7 to 22 in rows 1 and 2 were sprayed with 1 per cent Oronite Crystal oil with calcium caseinate as emulsifier. Trees 7 to 22 in rows 3 and 4 were sprayed with the same oil at a strength of 2 per cent, while the same trees in the 5th and 6th rows were sprayed with Mineral Seal oil at 2 per cent strength with the same emulsifier. Trees 2 to 12 in each of the six rows and trees 18 to 28 in rows 2 to 6 were then fumigated at intervals of from 1 to 10 days after the spray was applied. The figures in the squares represent the percentage of scale killed on each of the trees. It will be noted that there is a considerable range in the results, particularly in the single treatments. Since the figures given are from counts made on the fruit only the results are more favorable to the spray since the sprays effect a better kill on the fruit while fumigation effects a better kill on the leaves and branches.

If it is assumed that each of two treatments kill 90 per cent of the scale (which is not far from the results in practice) such a program should result in satisfactory control which might be explained entirely on a mathematical basis. For example, if there are 1,000 scales on a tree and one treatment kills 90 per cent, there will be 100 scales left. If a second treatment again kills 90 per cent there will be 10 scales left out of the original 1,000 or 99 per cent killed. But a double treatment of either a spray or a fumigation seldom effects such a result.

In the case of fumigation the writer has shown in previous work that scales which survive one fumigation will go through a second fumigation with a higher percentage of survival than scales which have not been previously fumigated. The same result was obtained with ladybird beetles. Where our present oil sprays may kill 90 per cent of the scales on the fruit this degree of control will not be maintained on the wood.

Inasmuch as a spray kills best on the fruit and a fumigation kills best on the branches, these treatments are complementary. In spraying also it is easier to cover the fruit on the outside than on the inside of the tree, while in fumigation the scales on the outside of the tree are more likely to escape because of the less concentration of gas near

the tent. Oil is a wax solvent, hence oil sprays, and particularly the heavy oils that remain in contact with the waxy covering of the scales for some time, tend to dissolve and in some cases to loosen such an armored scale as the red scale and thus make it possible for the gas to more readily reach the insect.

While spraying after the fumigation gave a fairly high kill, 97.7 per cent, this combination was not equal to the kill where the spray was followed by the fumigation, in which case it was 99.4 per cent. If the action of the spray may be accounted for as given above, then there is an advantage in applying the spray first. Another point in favor of applying the spray first is that the presence of oil on the tree tends to make the trees less susceptible to injury from hydrocyanic acid gas.

Hydrocyanic acid gas was bubbled through one of the oils and a test made for HCN as given in Scott's Standard Methods for Chemical Analysis and no HCN found. Another experiment consisted in filling a tray partly full with a 2 per cent sodium carbonate solution and then pouring over this a film of the oil. The tray was then placed in an atmosphere of HCN gas and the alkaline solution later tested for HCN but none penetrated through the oil film. A row of orange trees was next sprayed with a heavy oil spray and this row together with one adjoining not sprayed were fumigated with a high dosage (220%). The trees not sprayed were severely burned with this high dosage while the trees that were first sprayed were scarcely at all injured. This indicates that the oil acts as a protective film against HCN gas and enables a higher dosage to be applied with safety to the tree.

In the first publication issued on HCN fumigation for citrus trees, Bulletin 71 of the California Experiment Station 1887, it was stated that fumigation could not be carried on with safety to the tree unless carbon dioxide was also applied. A considerable amount of CO_2 released under the tent in the case of some of the trees in the present experiments just previous to the time when the charge of HCN was made, but the CO_2 had no protective action on the tree and trees so treated were as badly burned as the check trees.

It has been difficult to account for the high degree of control often observed in the field from the combination of spray and fumigation in view of the fact that it is scarcely possible to avoid missing small areas on the trees and fruit in the spray application. The scale on these areas should succumb no more readily to the fumigation than if no spray had been applied to the trees. The above tests where half of the fruits only were sprayed show that the results on the unsprayed

half were not satisfactory. The difference was sharply marked at the line of the sprayed portion which indicates the necessity of a thorough spray coverage. There is another factor, however, that may enter in field work. Previous experiments have shown that the foliage of the tree absorbs more or less of the gas and that this reduces the kill of the scale. If the covering of oil on the tree prevents absorption of the gas a higher efficiency may thus be secured from the fumigation alone.

TABLE 2.—GENERAL RESULTS OF THE DIFFERENT TREATMENTS AS GIVEN IN TABLE 1

(Figures given for fruit only)

Oil	Strength	No. trees	Scales exmd.	Av. % kill	Range % per tree
		Fumigation only (20 cc. dosage)			
		36	6400	84.01	100–49
		Spray only			
Oro. Crys.	2%	10	1350	92.1	100–83
Oro. Crys.	1%	10	1850	78.8	94–59
Min. Seal	2%	10	950	91.2	98–82
All sprays		30	4150	87.4	100–59
		Fumigation after spray			
Oro. Crys.	2%	22	3650	99.4	100–95
Oro. Crys.	1%	22	3820	97.6	100–90
Min. Seal	2%	22	1500	97.2	100–86
		Spray after fumigation			
Oro. Crys.	2%	22	3400	97.7	100–86

Fumigation interval after spray

Oil	Strength	Interval	No. trees	Av. % kill	Range % per tree
Oro. Crys.	2%	Fum. next day	12	99.3	100–95
Oro. Crys.	2%	Fum. 10 days	10	99.7	100–99
Oro. Crys.	1%	Fum. next day	12	98.3	100–95
Oro. Crys.	1%	Fum. 10 days	5	96.0	98–90
Min. Seal	2%	Fum. 3 days	12	97.7	100–94
Min. Seal	2%	Fum. 6 days	10	96.8	100–86

TABLE 3.—SPRAY AND FUMIGATION FOR RED SCALE

Sprayed half of each lemon with Mineral Seal and Calcium Caseinate, 2 per cent, April 6. Fumigated these fruits, April 7, in 100 cu. ft. fumigatorium with 4 cc. of liquid for 35 minutes.

Results

Lemon No. 1	half not sprayed	22/4 alive
Lemon No. 1	half sprayed	40/0 alive
Lemon No. 2	half not sprayed	35/3 alive
Lemon No. 2	half sprayed	50/0 alive
Lemon No. 3	half not sprayed	70/9 alive
Lemon No. 3	half sprayed	55/0 alive
Lemon No. 4	half not sprayed	19/1 alive
Lemon No. 4	half sprayed	50/0 alive
Lemon No. 5	half not sprayed	50/1 alive
Lemon No. 5	half sprayed	40/0 alive

	Totals	Kill
Half of 5 lemons fumigated only	196/27	86.3%
Half of 5 lemons sprayed and fumigated	235/0	100 %
Lemons fumigated only (check lot)	800/54 alive	=93.3%

TABLE 4.—SPRAY AND FUMIGATION FOR RED SCALE

Sprayed with Mineral Seal, 2 per cent, April 15, one-half of each fruit, fumigated April 18, 4 cc. for 35 minutes in 100 cu. ft. fumigatorium.

Lemon No. 1	half not sprayed	90/1
Lemon No. 1	half sprayed	88/0
Lemon No. 2	half not sprayed	100/0
Lemon No. 2	half sprayed	100/0
Lemon No. 3	half not sprayed	60/1
Lemon No. 3	half sprayed	75/0
Lemon No. 4	half not sprayed	100/0
Lemon No. 4	half sprayed	60/0
Lemon No. 5	half not sprayed	60/1
Lemon No. 5	half sprayed	100/0
Lemon No. 6	half not sprayed	70/2
Lemon No. 6	half sprayed	60/0
Lemon No. 7	half not sprayed	60/0
Lemon No. 7	half sprayed	70/0
Lemon No. 8	half not sprayed	100/1
Lemon No. 8	half sprayed	85/0
Lemon No. 9	half not sprayed	50/7
Lemon No. 9	half sprayed	25/0

Totals

Half of lemons fumigated only	690/13	= 98.2%
Half of lemons sprayed and fumigated	663/0	=100 %
Lemons—half sprayed	460/9	= 98.1%
Lemons—half not sprayed (check)		= 45 %

Other tests included the spraying of half of lemons infested with red scale and the subjecting of these lemons to a fumigation to determine the exact kill of scale on the sprayed half and on the unsprayed half. A sample of a couple of these tests is given in tabular form in tables 3 and 4. It will be noted that in the first lot on the half lemons that had been fumigated only, there was a kill of 86.3 per cent. On the half lemons that had been both sprayed and fumigated there was a kill of 100 per cent. Where the lemons were fumigated only the kill was 93.3 per cent. In the other lot on the half lemons that were fumigated only there was a kill of 98.2 per cent and on the half lemons both sprayed and fumigated there was a kill of 100 per cent. In this case we check also on what the spray alone did and the kill was 98.1 per cent.

In some of the field results it has been difficult to account for the high efficiency of the double treatment when one considers that it is

scarcely possible, practically, to avoid missing small areas on the trees and fruits in the spray application and in these areas the scales should not be killed by the fumigation any more readily than if the trees had not been sprayed. Th above tests show that the spray on one-half of the fruit will not insure results on the other half.

CHAIRMAN DOANE: We will now have a paper by Ralph H. Smith, on Investigations on Arsenical Residues on Apples.

INVESTIGATIONS ON ARSENICIAL RESIDUES ON APPLES

By RALPH H. SMITH, *Citrus Experiment Station, Riverside, Calif.*

(Paper not received)

Adjourned.

MORNING SESSION, THURSDAY JUNE 23

The meeting was called to order at 9:30 A. M.

CHAIRMAN DOANE:—This morning we have a symposium with the Pacific Coast Entomological Society on the general subject "Arousing Public Interest in Entomology." The first paper will be given by Roy E. Campbell.

IS THERE A NEED OF INCREASED KNOWLEDGE OF ENTOMOLOGY

By ROY E. CAMPBELL, *Alhambra, California*

ABSTRACT

The general public, especially in these times of urban trends, does not have a sufficient knowledge of nature. The study of insects should form an important and interesting part of nature study. The increasing importance of insects as man's chief competitors makes it practically necessary that there be a more general knowledge of them. In the study of insects, and methods of combatting them, highly trained specialists are needed, and to provide these a greater interest in entomology must be aroused.

(Full text not submitted for publication)

A GREATER INTEREST IN ENTOMOLOGY FROM A PUBLIC HEALTH VIEWPOINT

By R. W. DOANE, *Stanford University, California*

(Paper not received.)

CHAIRMAN DOANE: The next paper will be read by the Secretary,

THE RELATION OF THE PUBLIC'S KNOWLEDGE OF INSECTS AND THEIR DESTRUCTIVENESS TO QUARANTINE ENFORCEMENT

By W. C. Jacobsen, *Chief, Bureau of Plant Quarantine and Pest Control, California State Department of Agriculture, Sacramento, Calif.*

Abstract

Growers, entomologists and others having a knowledge of economic insects either detailed or limited instinctively as a result of contact with pests are helpful and sympathetic to plant quarantine enforcement. Lack of interest in insect pests or their destructiveness by the general public is manifest in an apathy to quarantine enforcement work, probably due primarily to the personal inconveniences attendant. Popular yet brief accurate press items, also simple teachings in elementary schools and similar educational aids, are undoubtedly helpful.

In discussing a subject of this nature we must assume that certain definite groups which comprise our general public have a knowledge of insects, their destructiveness if pests, their value if beneficial, and, on the other hand, we know from experience that the vast majority of individuals have such a limited knowledge of this subject that as an aid to plant quarantine enforcement it is negligible. The inconvenience of inspection whether at maritime ports or at border highway stations overshadows any desire to learn more of the importance of pest prevention, unless information concerning the subject has been assimilated while at leisure and in such a way that traveling progress is not interrupted.

This probably accounts for the fact that passengers on vessels from Hawaii, whence might come the melon and Mediterranean fruit flies, are, as a general rule, better acquainted with the whys and wherefores of quarantine inspection than autoists who are hurrying to reach a destination. Short talks are provided by certain steamship companies on their boats enroute, supplemented by carefully illustrated and explanatory booklets, giving reasons for keeping out menacing pests at a time when the passenger looks upon any change of conversation or activity as a diversion from the ordinary routine encountered in the vessel's shoreward progress.

We can enumerate some of the groups who know of insects. Agriculturists, if successful operators, must sooner or later contact insect pests in an actual and real manner; hence, unconsciously acquire a fund of information which must be an aid in preventing pest introduction. Costs of control measures to combat destructive insects teach the grower that additional pests will increase overhead of crop production. He is consequently sympathetic toward plant quarantine activities from a self preservation viewpoint. He has at his command, sources

of information, e. g., from extension service agents, regulatory officers and insecticide salesmen, which augments his knowledge already increasing from personal experiences. He is loath to see additional pests introduced.

Individuals who have had educational advantages embodying biological curricula or those to whom entomology naturally appeals are readily convinced. Still others are attracted to a knowledge of the subject because of the beauty of some species, such as butterflies, certain beetles and so forth, and are led to investigate further with reference to the habits not only of their original hobby, but also of other members of this interesting group of the animal kingdom. Freak occurrences involving insects lead to a recognition that in the subject of entomology there are bits of pleasing stories. Thistle butterfly flights, grasshopper or locust plagues, army worm marches, jumping beans and auto radiators plastered with moths, flies or butterflies are frequently starting points for the layman to gain entomological information if he chances to question the right person.

This is similarly true of garden lovers, who, because of pests on their choice flowers or coveted "personally conducted" vegetables, want to know immediately and absolutely what the bug is and how it can be annihilated. Again, if termites, for example, begin to show evidence of annoyance and property damage, a personal interest develops in the party affected.

So far, those mentioned have had individual contacts either directly or indirectly with insects in such a manner that it is not difficult to point out to them the value of stemming the arrival of new pests. There are many others directly in contact with phases of agricultural production and marketing who know of the many Entomological problems, but in the main their information is quite casual.

The average everyday person regards the subject of entomology as demanding interminable study; as a sort of wizardry that only a technical scientist can comprehend and believes the absorption of even popular data on insects as beyond his reach. If he could be taught the affects possible on his daily bread or the foods he enjoys both as to condition and cost he might better understand the profound importance of pest suppression. Too frequently the whole matter of whether insects will concern an individual or not is dependent upon how it affects his personal convenience. If inconvenient, an apathy can grow up, in spite of potential damage apparent, to the whole gamut of pest suppression measures, be they spraying, dusting, or plant quarantine regulations.

To overlook entomologists in their relation to plant quarantine enforcement would be remission of duty. Here we assure ourselves that we deal with a group comprising the highest trained participants in insect lore. The knowledge of principles of insect distribution and ecology reach their highest levels among this fraternity, and here too the enormous destructiveness of insect crop feeders is well understood. Fortunately, we can say that the vast majority of specialists in this field, together with the plant pathologists, are our mainstays of helpfulness. Yet, how many entomologists dogmatically predict the complete ineffectiveness of quarantine promulgations? The mere predictions might be harmless but there are, unfortunately, a few who believe themselves above the plane of being quarantine violators and who may ignore the dangers they subject agriculture to in the pursuit of their profession. In collecting specimens of insects they have been known to transport live injurious insects into uninfested territory not only a few miles but between counties, yes, even between states. At this moment we recall an incident at such a session as this of an insect of sufficient consequence to demand a federal quarantine being illegally transported into California where the host crop was free of this and similar pests.

Nurserymen and growers credit scientists and even regulatory officers with being responsible for pest distribution and unfortunately at times they are correct. Last year we chanced upon a quarantine inspector in another state transporting an injurious insect into clean territory merely to satisfy the curiosity of a convention. In both cases we believe the incidents happened unthinkingly, yet, we take this opportunity to suggest care and thoughtfulness of the consequences when dealing with potential or known crop destroying insects.

This leads to the mention of groups of persons who should have at least a chatting acquaintance with insects and their damage. Bankers at this day and age control many acres of fertile farm lands, either through mortgages, term loans, or actual bank ownership from foreclosures. One of the economic difficulties this group is now encountering is land management, generally entrusted to a city bred subordinate officer. He may know a little about entomology but generally prides in the remark that his business is banking not farming. We might place in a similar category city dwelling industrial executives and attorneys who have no patience with explanatory information but will take up the matter of being "insulted" by the inspection officer with "your superiors" or even the Governor. Fortunately, in California, where agricultural resources are recognized as basic, these occurrences are limited and pest knowledge is sought and accepted in the main.

We hold that attorneys should be more sympathetic toward gaining some entomological information. They are governed by the rules of proof and precedent laid down by man-made laws. Could they realize that biological laws which govern in matters of pest control or prevention could often be correlated with sound reasoning rather than opposed to judicial reasoning, broader interpretations in court cases involving quarantine would result. A justice of the peace in a farming community instinctively is helpful, but professional attorneys and jurists are prone to uphold the property rights of the individual rather than the state or nation-wide rights to protection against pest invasion. Technically, perhaps right, but biologically in error.

Economic surveys are made of areas to determine their value for agriculture or their ability to stand the burden of bonded indebtedness for irrigation, reclamation or drainage works. Insignificant factors are given detailed consideration, yet, how often will the engineers who figure a project even give semblance of thought to pest invasion possibilities, or the security from such invasion by adequate regulatory enactments? We personally have heard it suggested but once. Even established or native insects are overlooked. Land values can be depreciated in a time far shorter than that generally allotted for paying off indebtedness if factors governing insect pest possibilities are not countenanced. Specialists in other lines of agricultural activities frequently ignore entomological information when it could be engaged to advantage. A profitable agriculture can be relegated to virgin soil conditions by lack of proper understanding of pest damage.

The value of a gained familiarity, even though limited, of insects and the crop losses caused by them is remarkably demonstrated in the case of some of our common carrier employees. It is true that they are responsible if quarantine regulations are violated by their companies but it has been surprising how their contacts with horticultural inspectors have built up at least a speaking acquaintance with some of these "terrible bugs and contagious plant microbes." Further, a group of executive officers of transportation companies meet with our Western Plant Quarantine Board each year to keep in touch with pest developments and serve as a clearing house each for their own lines whenever pest or plant quarantine matters arise. They have agricultural tonnage to transport; hence, should insect damage reduce the quality of commodities be it fruit, field crops or vegetables, or even cut down the volume, they have a loss of revenue. These men have developed a knowledge of insect damage which has materially aided plant quarantine enforcement both at origin and destination.

The question will be asked—how can a knowledge of insect pests and their damage be bettered if it is helpful? Entomologists have an exceedingly interesting, almost intriguing story if it can only be told so the public can grasp the thought. Professional standards are not necessarily deprecated if technical verbiage can give way to some extent to a simple diction so long as the facts stated are sound. Among the most mystifying yet interesting processes in life are the metamorphosis stages in insects, yet, the average layman has difficulty in comprehending even the beginning thoughts along this line. At least the outstanding pests could be written about in simple style, indicating the relationships in life history stages to the effects on the host. Man is interested in his foods, his house, his garden and his clothing. News reporters evidence their use for such material but too frequently they consider this type of data as "freak stuff." This can be overcome and in truly farming communities has already to a large degree. Conservative, simple and carefully illustrated articles are helpful and admittedly demand patience. It will certainly not detract any from the public support to entomological work of any kind.

School children in Honolulú make regular visits to the plant inspection house there. They learn of the biological control work and ask of the need for it, what brought it about, where did the serious pests come from anyway and couldn't they have been stopped. Their line of questioning involves the very things many other folks would like to know. Schools could well encourage more insect stories if only they could be supplied in simple form. Insect pests thus become widely known, superficially to be sure, but understandingly.

We conclude that any sound, truthful knowledge of insects and the losses caused or the benefits resulting in certain cases, is an appreciable aid in plant quarantine enforcement. If the funds expended to adequately maintain quarantines represent the premium on an insurance policy to protect against pest introduction, then, certainly a knowledge of crop consuming pests is the impelling interest in obligating the state or the nation to make application for such an insurance policy and furnishes the continued impetus to see the premium paid, as well as causing the public generally to recognize a patriotic responsibility.

CHAIRMAN DOANE: The next paper is by Mr. Cain.

INTERESTING BOY SCOUTS IN ENTOMOLOGY

By BRIGHTON C. CAIN, M.A., *Naturalist for the Oakland District Council Boy Scouts of America*

ABSTRACT

Learning by doing is a watchword of Scouting. Scouting and Outing go hand in hand, so entomology is well suited to the scout method of training. An important factor in character building is a better understanding and appreciation of Nature. Insects with their limitless varieties of forms, array of colors, diversity of habits and their interrelationships serve admirable for studying Nature. One method of scout advancement is through Merit Badge activities, and one of the many subjects for which a scout can qualify for such a badge is Insect Life. Boys show a keen interest in collecting and field studies of insects, especially if given a little encouragement and assistance. Field trips, or "bug hikes" serve to keep up the interest.

It is only a few short years since Scouting was organized in this Country and given an official stamp of recognition from our Government, but even seventeen brief years have been sufficient to establish it as a great force in character education employing sound pedagogical methods. So perhaps it may be well for us to consider briefly how Entomology may be vitalized in the Scouting Movement.

The genius of Scouting is found in its dynamic qualities, for "Learning by Doing" is ever the watchword. The project method and the recreational methods of instructing our youths are a real contribution from the Scouting Movement. And since Scouting and Outing go hand in hand, a subject like Entomology is admirably suited to the scout method of training.

A very important factor in building character is the bringing of the individual into better understanding and keener appreciation of the unfathomable beauties of Nature and of Nature's God. Where, in all the world about us, is there a more wonderful field than Entomology for just this sort of thing? With the seemingly limitless variety of forms, the vast array of colors, the great diversity of habits and the marvelous interrelationships, presented by the insect world what a golden opportunity is ours for instilling *real* Reverence in the boys of today, who will soon be the "men of tomorrow."

The test of a good Scout is whether he is really *living*, in his everyday life, the Oath and Law to which he subscribed on joining the Movement. But in addition to this a wide-awake youngster is always keen to make progress along the lines of scout advancement. The highest development of the educational program in Scouting is in the field of Merit Badge activities.

We find in that field a group of 76 different subjects in which a scout may qualify for a badge of merit, upon fulfilling certain nationally

prescribed requirements. A scout may pick and choose as he pleases from this group, participation in this phase of the program being purely voluntary. A few subjects are particularly designed to render the boy capable of great service to others in times of emergency, but most of the remainder serve to open to the lad a wide variety of vocational and avocational interests which will be of tremendous value to him throughout his life. Naturally many merit badge subjects are directly concerned with the out-of-doors, and one of these is designated as "Insect Life."

That title was happily chosen, for emphasis is placed on the *living* insect, and a knowledge of its habits and habitat. To be sure, a collection of 50 insects, collected, mounted and labelled by the scout is one of the requirements for the badge, but the boy is also required to breed through all its stages at least one species of insect, to record his observations of an artificial ant nest or a bee colony for a period of at least two weeks, and then to go afield with the examiner and point out to him, in their *natural environment*, a considerable number of living insects. In short, the scout is encouraged to "study Nature and not books."

The printed page is, however, *one* of the means to the end of "Arousing Public Interest in Entomology." Our scouts have been aided by access to a nature library at Scout Camp containing a goodly number of books on Entomology. Perhaps mention should here be made of the following as being particularly helpful:

Insect Life Merit Badge Pamphlet by J. C. Bradley and E. L. Palmer of Cornell

Insects of Western North America by E. O. Essig

American Insects by V. L Kellogg

Introduction to Entomology by J. H. Comstock

The first named reference was published by the Boy Scouts of America in 1925. While largely a compilation of previously published illustrations and material, it is very useful to a scout, because it specifically deals with the requirements for the Insect Life merit badge. It is very entertainingly written and is made even more intriguing by a marginal gloss by Mrs. Comstock.

A further means of stimulating interest in Entomology amongst our Scouts is the access at Diamond Camp (which, by the way, is in the Oakland hills only 5 miles from the City Hall) to a collection of several thousand insects made by the writer during the past several years in many western states. This serves not only as a source of information, but also serves to create interest not otherwise aroused.

The maintaining of a ready source of supply of needed equipment,

such as pins, forceps, materials for killing-bottles and nets, etc., at the lowest possible cost, is also helpful in promoting interest in six-legged creatures.

The playing of nature games, which involve insects, at Troop meetings and on week-end Nature Rambles likewise serves to create and maintain interest.

The sincerely cordial interest and desire to be of service on the part of the entomologists affiliated with the nearby University of California and the California Academy of Sciences in San Francisco cannot be overlooked as a great aid to those scouts who have developed through Scouting an unusual interest in the study of insects.

Last but not least, perhaps, in developing entomological interest in our lads are the frequent trips afield, often specifically designated as "Bug Hikes," but always to keep alert to everything in nature that can challenge our interest. Perhaps thru these various means it will be possible to develop a few real field naturalists, the dearth of which has been rather keenly felt for many years.

A new undertaking with the writer is the taking of nature movies which he is employing successfully with birds, mammals and reptiles. It is hoped to turn it also to insects and perhaps *that* may be a means of vitalizing the true, weird tales of insect activity that can so readily hold a group of boisterous youngsters speechless at some indoor troop meeting next winter.

In conclusion, let it be said that all of this work is somewhat of a pioneer effort and much is yet to be learned, as the writer is the first, if not the only, trained naturalist to be employed by a Scout Council on a full time, year round basis to promote the nature program. Since at least two Oakland Scouts have decided to enter Entomology as a profession and scores of others have developed a healthy outdoor interest in insects as a hobby, and since "*Bugs*" Cain has become known to at least twenty-five hundred scouts as a guide who would bring them into a closer harmony with the birds, the bugs, the reptiles, the rocks and the stars, perhaps the experiment has not been in vain.

CHAIRMAN DOANE: The next paper is by Mr. Freeborn.

EFFICIENT AND PRACTICAL CONTROL OF HOUSEFLIES

By STANLEY B. FREEBORN, *University of California, Davis, Calif.*

(Paper not received).

CHAIRMAN DOANE: The next paper will be by Mr. S. J. Snow.

EFFECT OF OVULATION ON THE SEASONAL HISTORY OF THE ALFALFA WEEVIL

By S. J. SNOW, *Bureau of Entomology, Salt Lake City, Utah*

(Paper not received)

CHAIRMAN DOANE: The chairman is down for the next paper.

DIFFICULTIES IN MOSQUITO CONTROL

By R. W. DOANE, *Stanford University, Calif.*

ABSTRACT

This paper is limited to a discussion of some of the problems that arise in the Mosquito Abatement Districts in the San Francisco Bay Region where reclamation and industrial projects have complicated a situation that was at first a comparatively simple one.

In 1905 Prof. H. J. Quayle first demonstrated the possibility of controlling mosquitoes in the San Francisco Bay Region at a comparatively small cost. He found that the most important part of his work was on the salt marshes, for the mosquitoes that were breeding there would fly inland and become an almost unendurable nuisance. He found that most of the breeding places on the marshes could be controlled by simply draining the tide pools that were filled during the times of the monthly high tides but were not reached by the ordinary daily tides. At this time, too, he met the problem of the dyked lands and a large part of his time and available funds had to be expended in meeting the difficulties presented there.

With the organization of the Mosquito Abatement Districts under the law passed in 1915 these same problems had to be met and solved. In districts where there were no dyked areas a comparatively small amount of ditching, supplemented with some oiling, was all that was necessary to get effective, economical control of the marsh-breeding mosquitoes. But these ideal, primitive conditions did not last long. Salt companies and other concerns began to extend the areas used for industrial purposes and this meant more dykes and ditches which often formed troublesome breeding places.

The evaporating beds used by the salt companies are, in themselves, not a nuisance, for the water in such places is so dense that the mosquitoes will not breed in it. The ditches made while constructing these dykes do, however, often make prolific breeding places unless measures are taken to prevent water collecting and standing in them. Connecting

these ditches with the open bay or with wide sloughs in such a way that the daily tides will ebb and flow in them will also be effective.

Most trouble comes about on the lands that are being drained or have been previously drained and reclaimed for agricultural or other purposes. As soon as these lands begin to dry a great network of cracks is formed. These cracks are from a few inches to a foot or more in width and they may be as much as two to four feet deep. Before the land is thoroughly drained or after heavy winter rains the water that is to be found in these cracks is often swarming with mosquito larvae and pupae. Many of these cracks are often covered, or nearly covered, with the marsh grasses so it soon becomes a difficult and dangerous undertaking to try to walk over such lands. When the cracks are first forming a measure of mosquito control may be obtained by oiling the breeding places that can be discovered but this is a very expensive and unsatisfactory undertaking at the best. A little later, oiling becomes impractical and unless the water level can be lowered so the water will not stand in these cracks, the whole area becomes a serious menace. A good series of self acting flood gates often supplemented by pumps makes the most efficient drainage system. As soon as the land can be plowed and the cracks filled the land ceases to be a menace.

The law under which these districts were organized gave the boards of trustees power to take any steps that they deemed necessary for controlling mosquitoes, but the wording of the law was such as to make it seem necessary for the district to bear all of the expenses of such work. Some of the districts had thoroughly drained all of their tide lands and had them in such a condition that the mosquitoes could be controlled with but little trouble and expense. When some of these lands began to be reclaimed for agricultural or other purposes the conditions described above were brought about and it became necessary for the district to again expend large sums to correct the conditions brought about by the companies that were reclaiming the lands. This did not seem fair to the residents of these districts and in 1927 they asked that the law be revised so as to give the trustees of the district power to compel the owner of any land to bear the expense of any mosquito control work that was made necessary by his own operations or changes on his property. This law was passed and it is hoped that it will materially help the trustees of the various districts to meet this difficulty.

Another difficulty even more serious confronts some of the Abatement Districts. Unfortunately all of the tide lands in the bay region are not included in organized Mosquito Abatement Districts. It too frequently

happens that some of the districts will care for all of the breeding places in their own districts but this work avails them little if they have an invasion of mosquito pests from some unorganized district. The two most common species of mosquitoes, *Aedes dorsalis* and *A. squamiger*, that breed on the salt marshes fly, or are carried by the winds, for several miles. They have been captured in the foothills five or six miles from their nearest breeding places.

Careful observations during 1926 and 1927 have shown that the open bay is no barrier to their migrations. Serious invasions of mosquitoes have been experienced in the districts on the west side of the bay when it was definitely known that few or no mosquitoes were breeding on that side of the bay. Inspections have shown that at the time of these invasions the tide lands on the opposite side of the bay were swarming with mosquitoes and the pools and other breeding places were abundantly filled with larvae and pupae. We have not yet been able to mark any mosquitoes on the east side of the bay and capture them on the west side but the mass of evidence that has accumulated in our studies of this situation shows beyond a doubt that great swarms, particularly of *Aedes squamiger*, do come from across the bay and make life miserable for people living from five to fifteen miles from the known breeding places. The distances which they must fly over the water varies from one and a half to three miles.

It seems that the only remedy for this condition is for us who are tormented by these foreign foes to prevail upon our neighbors across the bay to organize abatement districts and destroy these breeding places. Or if they feel that they must have the mosquitoes they should keep them at home. The smaller towns in Alameda County have signified their willingness to cooperate in this but the apathy of the residents of the bigger cities has so far prevented the organization of the district.

CHAIRMAN DOANE: The next paper is by Mr. Carter.

ISOLATION OF CERTAIN YEASTS AND ALLIED FORMS FROM *EUTETTIX TENELLUS* BAKER

By WALTER CARTER, *Bureau of Entomology, Twin Falls, Idaho*

(Paper withdrawn for publication elsewhere).

The following papers were read by title.

PROGRESS REPORT ON THE USE OF PETROLEUM OIL AS AN INSECTICIDAL SPRAY

By E. R. deONG, *University of California, Berkeley, Calif.*

THE USE OF OIL SPRAYS ON CITRUS DURING 1926

By R. S. WOGLUM, *Entomologist, California Fruit Growers Exchange, Los Angeles, California*

SIGNIFICANCE OF MID SEASON UNIT COUNTS ON RESISTANT BLACK SCALE

By A. F. SWAIN, *Citrus Entomologist and* CHAS. E. DUGGAN, *Field Entomologist, California Cyanide Company, Los Angeles, California*

NOTES ON THE PHYSIOLOGICAL EFFECTS OF SATURATED (WHITE) OIL ON CITRUS

By HUGH KNIGHT and CHAS. D. SAMUELS, *California Spray Company*

Before adjournment for the final business session Mr. J. A. Hvslop, of Washington, D. C., gave a talk on the Insect Pest Survey, explaining the nature of the work, and what is expected to be accomplished. A request was made of all entomologists to assist by sending in reports of insect outbreaks, no matter how seemingly trivial or important.

FLUOSILICATES AS INSECTICIDES FOR THE JAPANESE BEETLE[1]

By WALTER E. FLEMING,[2] *Associate Entomologist, Fruit Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

The insecticidal value of the fluosilicates for control of the Japanese beetle was studied during the past two seasons. The results indicate that the fluosilicates of barium, potassium and sodium are of the same order of toxicity as acid lead arsenate.

INTRODUCTION

The attention of entomologists was first drawn to the possible value of the fluosilicates as stomach poisons for phytophagous insects by Marcovitch (4, 5)[3] two years ago when he reported the results of his experiments with sodium fluosilicate in controlling the Mexican bean beetle. Since that time the fluosilicates have been tried with a certain

[1]Contribution No. 18 of the Japanese Beetle Laboratory, Riverton, N. J.

[2]The writer wishes to acknowledge the assistance rendered in this work by K. B. Rogers, J. M. Conroy, H. W. Coward, and A. T. Hawkinson who were temporarily connected with the Japanese Beetle Laboratory.

[3]Reference is made by number to "Literature Cited," p. 691.

amount of success on other leaf-chewing insects by Baerg (1), Ingram (2), Langford (3), Osborn (6) and Tattersfield and Gimingham (7). The experiments reported in this paper were begun in July, 1925, at the Japanese Beetle Laboratory in order to gain a better understanding of the fluosilicates and to produce, if possible, new materials for use in controlling the Japanese beetle, *Popillia japonica* Newm.

Physical and Chemical Properties of Fluosilicates

The fluosilicates are crystalline compounds more soluble in water than acid lead arsenate. The approximate amounts of the compounds which dissolve in 1000 parts of water were determined at room temperature by shaking an excess of the materials with 200 cc. portions of distilled water for fifteen hours, and, after the suspended material had settled, analyzing aliquot portions of the supernatant liquids. The results of these tests indicate that the following amounts of the compounds dissolve in 1000 parts of water: acid lead arsenate 0.16 parts, barium fluosilicate 0.34 parts, potassium fluosilicate 0.94 parts, cadmium fluosilicate 2.00 parts, calcium fluosilicate 3.11 parts, sodium fluosilicate 7.14 parts, copper fluosilicate 23.20 parts, strontium fluosilicate 32.00 parts, aluminium fluosilicate 40.00 parts, and zinc fluosilicate 50.00 parts. These fluosilicates were pulverized in a ball mill and dusted on foliage in order to study their covering and adherent properties. It was observed that the particles of the fluosilicates do not settle readily on the leaves and that a large majority of the particles which do adhere to the foliage are easily washed off by rain.

Modern spray practices are complicated procedures. Combinations of spray materials are frequently made to avoid separate applications. It is often desirable to combine a stomach poison with Bordeaux mixture, lime-sulfur solution, or soaps. In an attempt to throw some light on the compatibility of the fluosilicates with these sprays, a series of tests were made with these materials and the fluosilicates of potassium, sodium, barium, and calcium.

Bordeaux mixture (4–4–50) was added to the powdered fluosilicates in such proportions that the fluosilicates were in the concentration of 5 pounds per 50 gallons. The combinations were shaken for five minutes and then allowed to stand. It was found that the pale blue color of the Bordeaux mixture precipitate is changed to a greenish-blue and that the amount of soluble copper in the mixture is increased in the presence of the fluosilicates. Since Bordeaux mixture is essentially a mixture of copper hydroxide, calcium hydroxide, and calcium sulfate, it is very probable that the increase in the amount of water-soluble

copper in the combination is due to the formation of some copper fluosilicate. The excess alkali in the Bordeaux mixture tends to decompose the fluosilicates into the fluorides and this reaction possibly accounts for the change in color of the precipitate.

Soap solutions, containing 5 pounds of sodium or potassium oleate per 50 gallons, were shaken with the fluosilicates for five minutes and then allowed to stand. As was anticipated, no reaction is apparent with the fluosilicates of sodium or potassium, but the fluosilicates of barium and calcium form the insoluble oleates. The free alkali, which forms when soaps hydrolyze in water, tends to convert a certain part of the fluosilicates into fluorides.

The tests made with lime-sulfur solution (1:9) and fluosilicate indicate that the mixtures are not compatible. When fluosilicates are added to lime-sulfur solution, a yellow precipitate is formed which gradually turns white and hydrogen sulfide is evolved. The reaction is vigorous with the fluosilicates of sodium and calcium and moderate with the potassium and barium salts. The rate of reaction seems to increase in the order barium, potassium, calcium, and sodium which also is the order of increase in solubility of these compounds.

Relative Toxicities of Fluosilicates and Acid Arsenate of Lead

It is necessary to confine the Japanese beetles in cages in order to keep them under observation because the insect, although gregarious, is a strong flier and makes frequent changes from one food plant to another. Fifty beetles, fresh from the field, were placed in each cage. Two cages of beetles were not given any food, to determine the mortality caused by starvation during the course of the experiment. Untreated smartweed, a favorite food plant of the beetle, was placed in two cages to serve as a check. Smartweed dusted with acid lead arsenate was put in two cages, and the other pairs of cages were filled with smartweed which had been dusted with the different fluosilicates. A daily record was kept for five days after the start of the experiment on the number of beetles dead in each cage, those apparently sick, those apparently unaffected and on the general reaction of the beetles to the different compounds.

The results of experiments made at different times throughout the past two summers indicate that some of the fluosilicates are just as efficient as acid lead arsenate in killing the beetle and others are of little value. The toxicities of the fluosilicates, expressed as the percentage efficiency of the compounds in killing as compared with acid

lead arsenate[4] are as follows: cadmium fluosilicate 6.9 ±1.18 per cent[5], aluminium fluosilicate 11.6 ±0.08 per cent, copper fluosilicate 12.6 ±1.55 per cent, strontium fluosilicate 29.8 ±1.84 per cent, zinc fluosilicate 40.3 ±0.90 per cent, calcium fluosilicate 53.8 ±4.09 per cent, barium fluosilicate 97.5 ±3.20 per cent, potassium fluosilicate 98.2 ±2.75 per cent, sodium fluosilicate 109.2 ±5.38 per cent. The beetle feeds extensively on foliage dusted with the fluosilicates of cadmium, aluminium and copper; it feeds moderately on foliage dusted with fluosilicates of strontium, zinc and calcium; and it feeds very lightly on foliage dusted with the fluosilicates of barium, potassium and sodium. It seems as though the fluosilicates of cadmium, aluminium and copper can be considered as having very little toxicity for the Japanese beetle. The fluosilicates of strontium, zinc and calcium are moderately poisonous, and the fluosilicates of barium, potassium and sodium seem to be of the same order of toxicity as acid lead arsenate.

Effect of Fluosilicates on Foliage

Experiments with the fluosilicates on foliage were carried out in 1925 and 1926 in the insectary and in the greenhouse. Fluosilicates were dusted on apple, peach, bean, and smartweed foliage. Sprays containing from 1 to 5 pounds of the fluosilicates were also used on the plants.

The results of these laboratory experiments indicate that the foliage of apple, peach, and bean is not injured to any extent by the fluosilicates of barium, potassium and sodium. The other fluosilicates cause more or less severe damage to the foliage of these plants. All of the fluosilicates injured smartweed foliage.

Effectiveness of Dilutants in Preventing Foliage Injury

The damage to foliage, to some extent at least, results from excessive amounts of soluble fluosilicate in contact with the surface of the leaf.

[4]The percentage efficiency was calculated by dividing the number of beetles killed by the fluosilicate by the number killed by acid lead arsenate at the end of the third day under the same conditions.

The comparisons were made at the end of the third day because the number of beetles dead in the cages without any food sometimes became so large after this period of time that it is difficult to decide whether the deaths in the groups of beetles exposed to poisons are caused by the action of the poisons or by starvation. The mortality due to starvation was usually low over a three day period.

The average mortality of beetles in 26 triplicate tests with acid lead arsenate dust was 75.4 ± 1.79 per cent. These tests were made at intervals throughout the seasons of 1925 and 1926.

[5]The probable error was calculated by the formula: $0.6745 \frac{S.D}{\sqrt{n}}$

It seemed very probable that a mixture of a fluosilicate with some material could be developed which would afford protection to foliage without impairing the insecticidal value of the fluosilicate. A series of tests was accordingly made to determine the value of different materials in preventing the injury of the fluosilicates of sodium, potassium, barium and calcium to smartweed foliage. The smartweed plant was chosen because of its apparent sensitiveness to fluosilicates.

Hydrated lime has been recommended by Baerg (1), Ingram (2), Marcovitch (4, 5) and others as a means of overcoming the injury by fluosilicates to foliage. Lime has no detrimental effect on smartweed foliage. A series of mixtures of lime and the fluosilicates were prepared, which varied in composition from 10 per cent to 90 per cent lime, and dusted and sprayed on the foliage. It was found that the injury tends to decrease as the proportion of lime in the mixtures is increased. No injury results from mixtures of the fluosilicates of barium and potassium with the higher proportions of lime. The calcium and sodium salts, even in the highest dilutions, still have a detrimental effect on the foliage of this plant.

In the studies with talc as a dilutant for the fluosilicates, it was found that talc tends to decrease the injurious action only as long as no moisture comes in contact with the mixture on the leaves. When talc-fluosilicate mixtures are sprayed or when moisture comes in contact with the dusts, severe damage to the foliage results.

Charcoal, clay, flour and starch seem to act as mechanical dilutants, tending only to delay the action of the fluosilicates.

"Coated fluosilicates" were prepared by stirring the pulverized fluosilicate into a benzene solution of lead oleate and then evaporating off the solvent. Lead oleate was used in proportions of 1 per cent, 2 per cent, 3 per cent, 4 per cent, and 5 per cent. It was found that when these mixtures are dusted on foliage, the particles settle readily on the leaves and adhere much better than the untreated particles. The "coated fluosilicates" prepared by this method do not mix readily with water and consequently do not make good sprays. It was necessary to use vigorous agitation in applying the sprays of these mixtures to foliage. The results of these experiments indicate that lead oleate does not protect the foliage from the injurious action of the fluosilicates. The mixture of barium fluosilicate containing 2 per cent lead oleate seems to be the best of all of the fluosilicate-lead oleate mixtures.

Effect of Dilutants on Toxicity

The effect of the different dilutants on the toxicity of the fluosilicates was studied by confining groups of beetles in cages, as outlined previously, with smartweed dusted and sprayed with the mixtures and observing the resulting mortality.

It was found that the addition of lime to the fluosilicates of barium, potassium, calcium and sodium makes the treated foliage more palatable to the insect. The extent of feeding increases progressively with the increase in the lime content until in the higher percentages of lime the foliage is entirely consumed. At the same time, the addition of lime decreases the killing power of the fluosilicate. The decrease in toxicity of the fluosilicates with the addition of lime is due to the use of a non-poisonous dilutant and to the conversion of a part of the fluosilicate into the less toxic fluoride by the lime.

The results of the experiments with the lead oleate-fluosilicate mixtures indicate that lead oleate does not affect the toxicity of the fluosilicates of sodium and potassium but it does seem to increase the toxic action of the barium and calcium salts. This apparent increase in the toxicity of the fluosilicates of barium and calcium may be due to fact that the lead oleate is not changed into a soluble oleate in these cases and tends to increase the adhesion of the fluosilicate particles to the surface of the leaf. It is possible to make much heavier coatings on leaves with the barium fluosilicate-lead oleate mixtures than with the untreated barium fluosilicate. Barium fluosilicate "coated" with 2 per cent lead oleate, which seems to be the best of these mixtures, has 125 per cent the efficiency of acid lead arsenate in killing the beetle.

Summary

The results of the laboratory studies of the physical, chemical and insecticidal properties of the fluosilicates may be summarized briefly as follows:

1. The fluosilicates are crystalline compounds more soluble in water than acid lead arsenate.
2. The particles of fluosilicates do not adhere readily to foliage.
3. Fluosilicates, in general, do not form compatible mixtures with Bordeaux mixture, lime sulfur solution, and soap solutions.
4. The fluosilicates of cadmium, aluminium, and copper are not efficient insecticides for the Japanese beetle, when compared with acid lead arsenate; fluosilicates of strontium, zinc and calcium are moderately efficient; and the fluosilicates of barium, potassium and sodium are of approximately the same order of toxicity as acid lead arsenate.

5. The foliage of apple, peach, and bean is slightly injured by the fluosilicates of sodium, potassium, and barium. The other fluosilicates damage severely the foliage of these plants. Smartweed, one of the favorite food plants of the beetle, is sensitive to fluosilicates.

6. Lime decreases the injurious action of fluosilicates on foliage but tends to destroy the toxicity of the fluosilicates.

7. Barium fluosilicate "coated" with lead oleate forms a material which is less injurious to foliage than the untreated fluosilicate. The mixture adheres to foliage and seems to be more toxic than acid lead arsenate.

Conclusions

The conclusions which may be drawn from this investigation are:

1. Fluosilicates of barium, potassium and sodium may be substituted for acid lead arsenate to kill the Japanese beetle.

2. Further work must be done with these materials to overcome their injurious action on plants and to improve their adhesion to foliage.

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THE STATUS OF THE ORIENTAL PEACH MOTH IN THE SOUTH

By Oliver I. Snapp, *in Charge, U. S. Peach Insect Laboratory, Fort Valley, Georgia*

Abstract

The Oriental peach moth (*Laspeyresia molesta* Busck) was first found in the South in the fall of 1923. Since that time inspections have revealed its presence in several localities of each of the Southern States, except South Carolina and Louisiana. Typical injury has been reported from those States. It is believed that the insect was brought into the South in infested apples. Studies of the life history and habits of the insect at Fort Valley, Ga., showed the occurrence of six generations and a

partial seventh in 1925, and five generations and a partial sixth in 1926. The use of bait pans for the control of a light infestation of the Oriental peach moth, such as occurs in Georgia, was unsatisfactory and impracticable. Neither in the past, nor at present, has the Oriental peach moth been of any economic importance in Georgia. Because of the absence of a host, to mature the broods of larvæ that hibernate, the chances are that it never will be a pest of major importance in the Georgia peach belt. The original light infestation in Georgia has shown a marked decrease during the last two years. At the present time the known infestation is confined to trees in several cities and towns, and to a part of only two commercial orchards in the peach belt.

The Oriental peach moth was not known to occur in the Southern States until the fall of 1923, when several larvæ were detected in peach twigs from the home orchard of R. M. Shaw, of Valdosta, Ga. Valdosta is about 100 miles south of the Georgia peach belt, and is in a section where very few peaches are grown. During the summer of the same year suspicious injury was observed on several peach trees in the town of Fort Valley, Ga., which is in the center of the peach belt, but no larvæ were taken for determination. During the spring of 1924 a number of larvæ were collected in twigs from these same peach trees in Fort Valley, and a determination showed that they were *Laspeyresia molesta* Busck. It is quite probable that the insect occurred at Fort Valley in 1923, the year it was found at Valdosta.

In July and August, 1924, the Federal Horticultural Board sent six inspectors into the Southern States to scout for the Oriental peach moth. From material sent in by these inspectors and by other entomological workers in the South, the insect has been determined from Raleigh, Taylorsville and Wilmington in North Carolina; Fort Valley, Macon, Thomasville and Valdosta in Georgia; Crestview, Gainesville, Jacksonville, Macclenny, Ocala, River Junction and Wildwood in Florida; Birmingham, Biluria, Mobile and Selma in Alabama; Byhalia, Olive Branch and Victoria in Mississippi; Bristol, Jackson, Knoxville, Lenoir City, Memphis and Sweetwater in Tennessee; Marianna, McGehee, Osceola and Wynne in Arkansas; and Dallas in Texas. Typical injury has been reported from many other localities in these states, and from South Carolina and Louisiana. Undoubtedly the insect occurs in a number of localities in the South other than those from which definite determinations of the insect have been made.

It is believed that this insect may have been brought into the South in infested apples. The first *L. molesta* larva collected in the Georgia peach belt was taken from a peach tree in the rear of a grocery store. It was learned that decayed apples were sometimes thrown out in the rear of this store. An adult *L. molesta* was reared from a larva in an

apple that was purchased at this place. The barrel from which it came showed that this apple was shipped from a locality in the North where the insect is known to occur. Shipments of apples had been made from there to a produce dealer in Macon, Ga., and then were jobbed to merchants in a number of localities in that state. In nearly every locality in the South where the insect is known to occur, the infestation is confined to trees within or very near to the city or town limits.

The life history and habits of the insect have been studied at Fort Valley, Ga., during the last two years. In 1925, six generations and a partial seventh were reared in the insectary at that point. In 1926, there were five generations and a partial sixth reared in the insectary. In 1925, the first moth of the spring brood emerged on March 8, and the last moth of the sixth brood emerged October 25. The emergence dates of the first and the last moth of each brood in 1925 were as follows: Spring brood, March 8 and April 25; first brood, April 28 and May 28; second brood, May 29 and June 25; third brood, June 26 and July 28; fourth brood, July 20 and August 28; fifth brood, August 18 and September 28; sixth brood, September 16 and October 25. In 1926 the first moth of the spring brood emerged on March 28, and the last moth of the last brood emerged on September 27. The emergence dates of the first and the last moth of each brood in 1926 were as follows: Spring brood, March 28 and June 7; first brood, May 19 and June 29; second brood, June 18 and August 1; third brood, July 17 and August 30; fourth brood, August 14 and September 20; fifth brood, September 10 and September 27.[1] In latitudes where this insect produces six or seven broods of larvæ annually, its hosts would perhaps be subjected to severe attacks if field conditions were favorable for the rearing of each generation. Parasites of the Oriental peach moth are evidently very scarce in the Georgia peach belt. Only two parasites were reared in connection with the life-history studies in 1925, and only one in 1926.

The infestation in the several infested peach orchards in Georgia has been too light for control experiments; consequently none have been undertaken, except to test out the bait pans. These were found to have a number of disadvantages under our commercial-orchard conditions. Had the Oriental peach moth infestation been heavy the bait pans might have been found more satisfactory. Very few moths were captured in the pans which were placed in the orchard showing the heaviest

[1]The life history records were taken in the insectary by C. H. Alden and H. S. Swingle of the U. S. Peach Insect Laboratory.

infestation in Georgia. Only 39 moths were captured from 10 pans in this orchard in 1925, and only 1 in 1926. Black-strap molasses (1 to 10) was used more than any other bait. High winds in the spring caused the bait to slop over, making an unsightly mess on the leaves and twigs, and necessitating daily refilling. The slopped-over material caused slight burning of leaves and peaches. In hot weather the black-strap formed a hard, gummy mass at the top of the pan, and when in that condition the attracted insects escaped. Molasses-yeast baits caused the formation of a thick scum which allowed some of the insects to escape. The pans were fastened by nails to the larger branches. This caused slight wounds with severe gumming of injured limbs. When the pans are tied on, the string causes wounds by cutting into the bark. The method requires too much hand labor and too much supervision, especially when the pans are placed high up in the trees. Even if it were effective, it would be a costly method. The fermenting molasses corrodes aluminum vessels, such as we used, thus requiring some replacement of pans from year to year. Twig injury by *L. molesta* larvæ was noted in both 1925 and 1926 before any moths were attracted to the pans, thus indicating that the method was of little value in determining the beginning of the respective broods. It is difficult to determine in the field whether the pest is the Oriental peach moth or a similar-appearing insect, because the molasses obscures the wings and the bodies of the moths. The pans caught fully as many beneficial as harmful insects, as, for instance, aphis lions, ants, and honeybees. The pans are often difficult to take down at the end of the season, because the bark has grown around the handle. In such cases a limb wound frequently results when removing the pans. Under conditions of light infestation, such as occur in Georgia, these bait pans have proven to be of no practical value in the control of the insect.

Neither in the past, nor at present, has the Oriental peach moth been of any economic importance in Georgia. The chances are that it never will be a pest of major importance in the Georgia peach belt, unless late fruit is planted, because no host is afforded for the maturing of the three last broods of larvæ. The harvest of the latest commercial variety of peaches is usually completed in Georgia before the last three broods of the Oriental peach moth have been produced. By that time, on account of the hardened condition of the peach twigs, the larvæ have ceased to work in them. Consequently there is an apparent heavy mortality of Oriental peach moth larvæ of broods that would hibernate, owing to the absence of a host after midsummer. Dead larvæ have been found frequently in peach twigs in Georgia after peach harvest,

their death apparently having resulted from an inability to feed in the hardened twigs. In 1925, fourth-brood larvæ were making their appearance in the Georgia peach belt during the harvest of Elberta peaches, the last commercial variety to ripen in that state. No larvæ of the fourth brood hibernated in 1925. The fifth, sixth, and seventh generations were reared in the insectary after peach harvest that year, and 13 per cent of the fifth, 65 per cent of the sixth, and 100 per cent of the seventh brood larvæ hibernated. In 1926, third-brood larvæ were making their appearance in the Georgia peach belt during the harvest of the last commercial variety of peaches. No larvæ of this generation hibernated. The larvæ in hibernation at the present time are made up of individuals of the fourth, fifth, and sixth broods. Thus the broods of peach moth larvæ that hibernate in central Georgia are not produced until after the fruit has been harvested, and when the twigs have hardened. Of course a few larvæ may reach maturity late in the season in water sprouts or sucker growth of neglected trees.

The infestation has not increased in Georgia since it was first found. As a matter of fact, it has decreased. It is the opinion of the writer that this has been owing to a heavy mortality of larvæ of the broods that hibernate. At the present time the known infestation in Georgia is confined to trees in several cities and town, and to only two commercial orchards in the peach belt. One of these is a small, isolated orchard, and the other is one adjoining a town, only the part within the city limits being infested. In every case at present the infestation is very light. Not a single injured twig was found this year in five commercial orchards in Georgia, parts of which showed an infestation in 1924 or 1925.

RECENT DEVELOPMENTS IN STRAWBERRY ROOT WEEVIL CONTROL

By W. Downes, *Victoria, B. C., Canada*

Abstract

The Strawberry Root Weevil (*Brachyrinus ovatus* L.) is the most serious pest of strawberries on the Pacific Coast. The history of past efforts to arrive at a satisfactory method of control is reviewed. Previous methods suggested by different workers have been cultural methods, including suitable crop rotation and the use of weevil proof barriers. The most recent method is by the use of poisoned bait, consisting of chopped evaporated apple waste. The poisons used may be Sodium fluosilicate, Magnesium arsenate, Calcium arsenate, and Sodium fluoride. All these have been found effective but in the experimental work at Victoria, Sodium fluosilicate was found the most satisfactory. Apple waste containing approximately 20 per cent moisture was found more attractive than super dried bait and Sodium

fluosilicate was found the most suitable poison to use with waste containing that degree of moisture. A strength of 5 per cent of poison was found to give the best results. Two applications of the bait are recommended, the first in April and the second in June.

Within the past two seasons a method of control for the Strawberry Root Weevil by means of poisoned bait has come into use which bids fair to solve the very difficult problem of the control of this pest. Attempts to arrive at a satisfactory method of control have been made by various workers for more than twenty years but nothing better was suggested for many years than cultural methods and crop rotation which in most cases were only half-measures and did not overcome the danger of immediate re-infestation. The first research work of any extensive character conducted in the Pacific Coast states was carried out by the late Prof. A. L. Lovett at Corvallis in 1912 and in the same year by the late R. C. Treherne at Hatzic in the Fraser Valley. The result of these investigations was simply to confirm the opinion of previous workers as to the desirability of proper crop rotation to avoid a concentration of the pest. Further work was carried on by the writer at Victoria, B. C., in 1918 and subsequent years in an attempt to solve the problem of artificial control. In this work the life-history of the weevil was still further elucidated and many trials were made of weevil-proof barriers in an endeavour to keep the insects out of the fields altogether. These methods proved more or less effective but had many objectionable features and did not prove sufficiently practical.

About four years ago Mr. M. J. Forsell, while working upon weevil control in the State of Washington, discovered that the adults were attracted by evaporated apples and a poisoned bait was devised, using evaporated apple waste as a carrier. In this bait magnesium arsenate was the poison used and the manufacture of the bait has now been placed on a commercial basis. In 1925 Melander and Spuler at Pullman, Wash.,[1] conducted experimental work with a view to determining whether the bait could be improved and cheapened. In these tests various attractants, principally essential oils, were tried with negative or inconclusive results and none were found superior to apple waste alone. Of the poisons used, magnesium arsenate, calcium arsenate and sodium fluoride were found effective in the order named.

During the past two seasons the writer has done considerable experimental work along similar lines at Victoria, B. C. In 1925 the experiments were of short duration but served to show that apple used alone was superior to various mixtures tried. In 1926 the experimental

[1]Melander, A. L., and Spuler A., Wash. Agr. Exp. Sta. Bul. 199. 1926.

work was confined to the use of evaporated apple waste as a carrier and the poisons used were sodium fluosilicate, magnesium arsenate, calcium arsenate and sodium fluoride. All these gave good results but sodium fluosilicate gave the best results during the entire season having regard to killing properties and the physical nature of the mixed bait. Sodium fluosilicate also has an advantage over magnesium arsenate in being cheaper.

In the manufacture of a commercial bait consideration has to be given to the behaviour of the bait under storage conditions. Ordinary evaporated apple waste contains from 20 to 24 per cent moisture and when such waste is chopped and mixed with magnesium arsenate or calcium arsenate, the resulting bait under the humid conditions of the coastal districts rapidly becomes so sticky as to be unusable. For this reason commercial bait is super dried to contain about 12 per cent moisture. When so dried it can be crushed instead of chopped and when mixed with magnesium arsenate does not become sticky. But the super drying deprives it of a certain amount of attractiveness and in our tests at Victoria the home made, freshly chopped bait, containing approximately 20 per cent moisture was found superior in nearly every test.

The use of sodium fluosilicate provides us with a poison bait that is not hygroscopic and at the same time possesses the maximum attractiveness. A heavy grade of sodium fluosilicate was used at the same strength as the other poisons tried, namely 5 per cent. The use of a fluoride compound also does away with the prevalent objection to using arsenates round about fruit that is shortly to be picked. A strength of 2½ per cent was found to be uncertain in its results. As regards the carrier, any form of apple waste, including fresh pomace, may be used when evaporated to 20 per cent moisture content. In our experimental work it was chopped by being put through an ordinary kitchen food chopper. And here lies the chief difficulty of preparing this bait under commercial conditions. Evaporated waste containing such an amount of moisture is so sticky and tough to cut that choppers rapidly become hot when run by power. We tried several types of vegetable cutters but they either became gummed up with the material or failed to cut it at all. Doubtless this difficulty will be surmounted in time by the production of a suitable machine. The difficulty has been got over by experimenters in Washington State by super drying the apple waste, which can then be crushed under rollers, but in our experience it then loses much of its attractiveness. The following are the summarized comparative results

of the baits used in field tests this summer at Victoria from June 2nd to July 6th:—

5 per cent	Sodium fluosilicate	93.3 per cent kill
	Magnesium arsenate	94.2 per cent kill
	Calcium arsenate	91.9 per cent kill
	Commercial bait	80.4 per cent kill

Sodium fluoride was used in one test only and gave a kill of 94.5 per cent as compared with sodium fluosilicate which gave a kill of 94.91 per cent. It is only fair to state that in some trials the commercial bait gave very good results. In April an application of commercial bait was made outside a weevil proof barrier where weevils were numerous, wandering up and down trying to cross, and a kill of over 90 per cent was obtained. On the other hand the kill with commercial bait was in some of our tests as low as 57 per cent. The weevils take the bait readily from the time they come out of hibernation until the middle of July in the coastal districts. After this period they feed less readily and the kills we obtained in our trials at that time were unsatisfactory. In interior districts, however, their development is less advanced and at Armstrong, B. C. on Aug. 11th kills were obtained, using calcium arsenate with evaporated waste and fresh evaporated pomace, of 89.4 and 93.5 per cent.

Having regard to the life-history of the weevil, it is apparent that two applications of the bait should be made, the first in April to destroy the overwintered adults and the second in June for the summer brood of weevils which emerge from the soil about that time. From 50 to 100 lbs. of bait is required per acre and it is applied by dropping a small handful down among the crown of the plants. In the writer's opinion success in keeping fields free from weevil will depend upon the time the bait is applied. This should be done if possible before any eggs are laid. When the mechanical difficulties of making the bait are overcome it appears as though this method of control will prove the simplest and most satisfactory yet devised, but the method has not yet been long enough in use to enable us to tell to what extent the fields will remain free from the pest. In all probability the necessity for proper crop rotation will remain, as in the past.

CHEMICAL TREATMENT OF BANDS AS A SUPPLEMENTAL CONTROL MEASURE FOR THE CODLING MOTH

By E. H. SIEGLER, *Assoc. Ent.;* LUTHER BROWN, *Asst. Ent.;* A. J. ACKERMAN, *Assoc. Ent.;* E. J. NEWCOMER, *Assoc. Ent.; Bureau of Entomology, United States Department of Agriculture.*[1]

ABSTRACT

As a result of preliminary tests, it is believed that bands employed as cocooning traps for codling moth, *Carpocapsa pomonella* L., larvae may be treated with a chemical toxic to the larvae. By use of a suitable chemical the necessity of removing and destroying, at regular intervals, the larvae that cocoon beneath the bands, may be obviated. In this connection, beta-naphthol and an oil emulsion have each given some promise.

Satisfactory control of the codling moth, *Carpocapsa pomonella* (L.), has not been obtained consistently in several of the important apple-growing regions. This is true particularly in many of the Central and Western States; and, under weather conditions favorable to the insect, serious outbreaks may occur here and there in the Eastern States.

Since, by present spraying practices, only a part of the surface of the fruit is covered with poison, the chances of a satisfactory kill are better where there is an average of 5 larvae attacking an apple during the season than where 25 attempt to enter. This ratio of codling moth population between the several orchard districts exists and accounts in a large degree for differences in success of control. While the writers believe at this time that proper spraying is by far the most practical means of control, they realize that efficient auxiliary methods, including general orchard sanitation with respect to packing houses and field boxes, would be desirable in regions where the codling moth is abundant. Many measures employed with the purpose of augmenting the spray practice have been used, such as (1) destruction of the mature larvae after they have left the fruit, (a) by scraping the loose bark from the trunk of the tree, (b) by killing the larvae that spin beneath bands applied to tree trunks; (2) destruction of the moths, (a) by light traps, (b) by wire-screen band traps, (c) by bait pan traps.

Generally speaking, supplemental control practices have not been popular and doubtless never will be employed extensively until their value has been established. This is somewhat difficult to ascertain under field conditions because of moth migration in the experimental plats.

[1]This work is being conducted at the field stations of the Division of Deciduous Fruit Insect Investigations located at Silver Spring, Md.; Bentonville, Ark.; and Yakima, Wash.

In the present paper on the chemical treatment of bands, the writers wish merely to present an idea with the hope that other entomologists interested in the subject may have opportunity to develop it further.

It is believed that a band of cloth may be impregnated with a chemical which will kill the larvae that spin between the band and the tree trunk. If a non-repelling chemical, toxic to the insect and non-injurious to the tree, can be found for this purpose, then the labor involved in destroying the larvae cocooned beneath bands will be obviated.

A few preliminary experiments have shown that a liberal application of beta-naphthol[2] (technical grade) to cloth bands killed the larvae that cocooned in contact with this material. The action was relatively slow, requiring from two to three weeks. These experiments were started rather late in the season of 1926, and although the prevalence of rain during the period of trial destroyed much of their value, sufficient evidence was obtained to indicate some promise. It was realized that this treatment would not be effective unless the chemical would resist the washing away by rain. To accomplish this end, it seemed feasible to make a waterproof mixture by means of the addition of lubricating oil to the beta-naphthol powder. This combination was made in the below proportions:

Beta-naphthol, tech'l	1 pound.
Lubricating oil (red engine type)	1 1/3 pints.

The above mixture has a consistency of paint of medium thickness and may be applied readily to a cheese-cloth band by means of a broad paint brush. The band should then be folded over once and may be run through a clothes wringer to insure saturation of the cloth and remove excess material. The above formula will provide sufficient material for 80 to 90 bands, each 3 feet in length and 4 inches in width when folded, at a cost of about ⅓ cent per band. These bands may be made in rolls and cut to any desired length at the time they are tacked to the tree trunk.

Since the full grown codling moth larvae are negatively phototropic,[3] they prefer to spin beneath dark colored materials. It is therefore believed that it would be desirable to dye the cheese-cloth black or else mix in a quantity of lamp black sufficient to accomplish the same end.

[2]Beta-naphthol, $C_{10}H_7OH$, is a light, fairly fluffy chemical in the form of minute scales; it is very slightly soluble in cold water and vaporizes rather slowly at summer temperatures.

[3]Bul. No. 932, U. S. Dept. of Agr. Life History of the Codling Moth in the Grand Valley of Colorado by E. H. Siegler and H. K. Plank.

With cheese-cloth at 7 to 8 cents per square yard, the total cost of the above described band, including chemical and dye compound, is about 2 1/8 cents.

The questions of the repelling effect of chemically treated bands and possible injury to the tree have not been carefully studied. Apparently, however, beta-naphthol is not a strong repellent nor is it injurious to the tree.

After further studies have been made along this line, other chemicals may be found that will work to even better advantage than beta-naphthol. A commercial brand of emulsion, containing a refined white oil (85 per cent oil) of which 95 per cent was unsulphonated residue, was employed in a test and with promising results. This emulsion was used at full strength on a burlap band.

It is planned to make further investigations along this line at several of the field stations of the Bureau of Entomology during the season of 1927.

PRELIMINARY EXPERIMENTS IN THE APPLICATION OF PARADICHLOROBENZENE IN LIQUID FORM AGAINST THE PEACH TREE BORER

By E. H. Siegler, *Associate Entomologist*, and Luther Brown, *Assistant Entomologist, Deciduous Fruit Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

Abstract

Paradichlorobenzene dissolved in high test gasoline and applied in liquid form around the base of the peach tree has been tested against the peach-tree borer, *Aegeria exitiosa* Say. Results of preliminary experiments have indicated that this chemical in solution was effective as a control measure.

Preliminary experiments conducted during the fall of 1926 have indicated that a solution of paradichlorobenzene may possibly be used for the control of the peach-tree borer, *Aegeria exitiosa* Say.

Several tests on a small scale involving dosages of 3/4 ounce and 1 ounce of the chemical in solution in comparison with the same amounts of the insecticide in crystalline form, were made on six-year-old peach trees on October 13, 1926, and examination of the results made on December 1, 1926. Tests were also made along other lines with special reference to possible saving of labor.

The crystals of paradichlorobenzene were dissolved in high-test gasoline which was used at the rate of 50 c. c. to each ounce of the crystals. The resulting solution was applied in a circle around the base of the tree by means of a small separatory funnel, the circle of liquid being about two inches distant from the trunk. This apparatus was

fairly convenient to use since the rate of flow was readily controlled by proper regulation of the stop-cock. In the application of the solution no attempt was made to remove debris from the base of the tree nor was the surface crust of the soil disturbed. The crystals of paradichlorobenzene were applied after the manner recommended by the Federal Bureau of Entomology.

The results of one test are given in Table 1, in which 1 ounce of the crystals was used in comparison with a solution containing a like amount of paradichlorobenzene. The results of the remaining tests will be noted during the spring of 1927.

TABLE 1.—COMPARATIVE RESULTS AGAINST THE PEACH TREE BORER OF APPLICATIONS OF PARADICHLOROBENZENE CRYSTALS AND OF A SOLUTION OF PARADICHLOROBENZENE IN GASOLINE (1 OUNCE IN 50 CC.)

	Paradichlorobenzene, 1 ounce				Check	
Tree	Crystals		Solution		(Untreated)	
No.	Larvae alive	Larvae dead*	Larvae alive	Larvae dead*	Larvae alive	Larvae dead
1	0	0	0	5	6	0
2	0	1	0	0	3	0
3	0	3	0	4	3	0
4	0	2	0	0	6	0
5	0	0	0	1	4	0
6	–	–	0	0	4	0
7	–	–	1	0	2	0
8	–	–	0	2	5	0
Total	0	6	1	12	33	0
Average per tree	0	1.20	0.12	1.50	4.12	0

*Several of the larvae found dead were decomposed.

In using a solution of paradichlorobenzene a somewhat different set of conditions is confronted than when the original crystalline form is applied. Upon evaporation of the solvent the paradichlorobenzene recrystallizes in a very finely divided state and is distributed in part below the surface of the soil. Further experiments will be made to determine what advantages or disadvantages a solution of the chemical may have as a control measure for the peach tree borer.

MOTH BORER DAMAGE TO DIFFERENT VARIETIES OF SUGAR CANE

By T. E. Holloway and W. E. Haley, *Bureau of Entomology, U. S. Department of Agriculture*

Abstract

To combat diseases and other troubles in the sugar cane fields of Louisiana varieties of cane from Java were recommended, and these were said to be resistant to the sugar cane moth borer. Field examinations indicate that they are not resistant. Nevertheless, their habit of long stubbling may reduce borer damage by reducing the number of hibernating larvae in planted seed cane. The situation is, however, complicated by other factors, as the extensive planting of corn, which is the favorite food plant.

As a foreword, it is necessary to explain to entomologists that the Louisiana sugar industry has steadily declined for a number of years until it has reached a precarious position. Some of the sugar planters have already been forced out of the business, and it is estimated that of those still operating about fifty per cent will be obliged to sell their holdings or go into bankruptcy.

There are several explanations for this condition. The planters have been farmers who were interested in finances and mechanics instead of in agriculture. As they have admitted, the farming has been left to poorly educated overseers in charge of gangs of negroes, while the owners have concerned themselves with the operation of the sugar factories and with the marketing of the crop. Diseases have been allowed to become widespread. Little or no effort has been made to fight insect pests. Soil improvement has been a very secondary matter. While the World War with its high prices put the planters on their feet temporarily, it merely delayed their downfall, and they are now paying dearly for their previous indifference to things agricultural.

Within the last two years new varieties of cane from Java have been advocated as a cure-all for these various troubles. These canes are indeed resistant or tolerant to the diseases, but in the opinion of the writers their planting should be accompanied with soil improvement work, insect control, and other advanced farm practices.

Among other claims made for the new "P. O. J." canes (so called for the Dutch words for "Experiment Station of Java") was that they were resistant to the sugar cane moth borer, *Diatraea saccharalis* Fab. Reports coming from Argentina, which of all sugar cane countries has a climate most like that of Louisiana, stated that with the general planting of the Java canes the moth borer had ceased to be a problem. To the writers it seemed that if the borer had ceased to be a pest it was not due so much to any resistance of the new varieties themselves as to another

cause. They explained it as follows: The new varieties have given a number of "stubble" crops in Argentina as against one or two stubble crops of the old varieties. This means that less and less cane is planted and more and more springs up year after year from the stubble. Now, it has been found that a dangerous source of borer infestation is in the planted stalks, the borer larvae developing in the stalks and the issuing adults making their way through the slight covering of soil, ready to oviposit on plants of the grass family. Thus, the less cane there was planted, the fewer borers were planted in the stalks, and as more and more of the long-stubbling Java varieties were planted the numbers of hibernating larvae were progressively reduced.

By cooperation with the Office of Sugar Plant Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, the writers have been able to make status examinations of a number of experimental plots of the new varieties, together with two old varieties, "D. 74" and "Louisiana Purple." The results are given in the following table.

Variety	At U. S. Field Sta., Houma, La.		At Abby-Highland Plantation, Thibodaux, La.		At P. R. Landry's Plantation, Lafayette, La.		Average
	Number of stalks bored per 100	Number of joints bored per stalk	Number of stalks bored per 100	Number of joints bored per stalk	Number of stalks bored per 100	Number of joints bored per stalk	percentage of stalks bored
POJ 826	36	2	54	2	62	2	
	43	2	42	3	48	2	47
POJ 36	36	2	30	1	32	1	
	40	3	30	1	58	2	37
POJ 234	44	3	34	1	88	2	
	54	3	58	3	80	2	59
POJ 213	72	3	96	4	96	2	
	74	5	98	4	98	4	89
D 74	62	3	54	3	—	—	
	44	2	64	3	—	—	56
La. Purple	—	—	—	—	86	2	
	—	—	—	—	92	2	89

The writers were also able to obtain some figures from the large fields at Southdown Plantation, Houma, La., and these are published by courtesy of the H. C. Minor Estate. P. O. J. 213 was 86% infested, with about 2 joints bored per stalk, while P. O. J. 36 was 73% infested, with about the same joint damage. P. O. J. 234 was 68% infested, with from 2 to 3 joints bored per stalk. P. O. J. 213 is therefore high in borer injury, though not as high as in the variety plots, while P. O. J. 36 and P. O. J. 234 are higher in the large fields than might have been expected from their results in the variety plots.

It appears from these results that the new varieties are not borer-resistant by any means, but that P. O. J. 213, on the other hand, is rather attractive to borers. Nevertheless, the extensive planting of these new canes, which is now going on in Louisiana, may have the effect of reducing borer injury if they grow from stubble for a long time as they are reported to do in Argentina. There is some question as to whether this will be the case. At the same time, the situation is complicated by other features, as for instance the extensive planting of corn on Louisiana sugar plantations, corn being the favorite food plant of the moth borer and often producing borers by the hundreds and thousands which in midsummer go over as moths to the adjoining sugar cane fields.

STATUS AND DISTRIBUTION OF SEVERAL IMPORTED INSECT PESTS IN PENNSYLVANIA

By C. H. Hadley

Abstract

Several major imported insect pests have in recent years been found in Pennsylvania, including the Japanese beetle (*Popillia japonica* Newm.), the European corn borer (*Pyrausta nubilalis* Hubn.), the Mexican bean beetle (*Epilachna corrupta* Muls.), and the Oriental fruit moth (*Laspeyresia molesta* Busck). Each of these species is apparently slowly spreading and increasing in economic importance. Two other species, the imported Willow leaf beetle (*Plagiodera versicolora* Laich) and the Apple and thorn skeletonizer (*Hemerophila pariana* Clerck), have both been found but have not as yet assumed a position of major economic importance.

Within the past few years several insect pests have been found in Pennsylvania, which have not hitherto been known to occur within the state. It seems likely that their original method of introduction into the state was largely through the movement of host plants, the type of movement which is not susceptible to control in a manner which will prevent the introduction of the insect concerned.

The Japanese Beetle (*Popillia japonica* Newm.)

Although the Japanese beetle was first discovered in New Jersey in 1916, it was not found in Pennsylvania until the summer of 1920, when it was found just across the Delaware River from the main infestation in New Jersey. The spread since that time has been rather uniform as to direction, and along lines which would naturally be expected and represents, it is believed, what may be expected in the way of yearly spread of this insect. At the present time it is distributed over that portion of southeastern Pennsylvania lying south of the first mountain range of the Allegheny chain, as far west as the Susquehanna River.

The territory involved comprises approximately 5325 square miles, which is 12 per cent of the total area of the state.

From the point where the insect was first found in Pennsylvania in 1920 to the farthest distant point where beetles were found during the past summer is almost exactly 100 miles in an airline distance, giving therefore an average annual rate of spread air line of about 15 miles per year.

The Japanese beetle is recognized as a pest of major importance to the agricultural crops in general, and particularly to fruit and shade trees.

EUROPEAN CORN BORER (*Pyrausta nubilalis* Hubn.)

The European corn borer was first found in the extreme northwestern corner of Pennsylvania in Erie County, in the early fall of 1919. It is thought that the infestation originated either in infested plant material drifting in the waters of Lake Erie, or possibly from the flight of moths from the early Ontario infestation. From 1919 to 1923 inclusive, the spread of the corn borer in northwestern Pennsylvania was relatively slow. However, since 1924 the spread has been both rapid and extensive, so that at the present time practically one-half the state is known to be infested. However, the area of general infestation is still limited to the northwestern corner of the state. Of the 67 counties of the state 30 are included in the territory quarantined for the corn borer, comprising approximately 24,000 square miles, or 54 per cent of the total area of the state.

Beyond any reasonable doubt the European corn borer may be considered as the outstanding agricultural insect pest, since it is a major pest of corn, and the corn crop is always the basis of agricultural production of all kinds.

MEXICAN BEAN BEETLE, (*Epilachna corrupta* Muls.)

The Mexican bean beetle is probably a very recent introduction into the state, having been found first in 1924 in the extreme southwestern corner of the state with a very limited distribution. The insect spread rather generally from its original source of infestation in 1925 in a fairly uniform direction. During the season just past the insect was found at isolated points some little distance from the previous year's infestation, but in several cases at least the point of finding this past season seems to be quite remote from the more generally infested area. However, since no extensive careful scouting was carried on over the territory as a whole, it is quite probable that the insect is more generally distributed, at least in the western and southwestern portions of the state than our records to date indicate. The outlying points of infestation are Venango County, Bedford County and Dauphin County.

The Mexican bean beetle to date has not caused any serious damage to any agricultural crop. During the summer of 1926, however, it did seriously reduce, and in a number of cases in the older infested territories, completely destroyed garden beans. All kinds of garden beans seem to be very susceptible to attack, and the outlook seems to be that this insect will be primarily a pest of garden beans.

THE ORIENTAL FRUIT MOTH (*Laspeyresia molesta* Busck)

The Oriental fruit moth was first noticed in Pennsylvania in numbers sufficient to cause loss in 1923, although it is quite probable that the insect actually occurred in a very limited way as early as 1919. At the present time practically every commercial peach growing section in the state is infested by this insect, it having been found in practically all the southern peach growing counties, in the vicinity of Pittsburgh, and in Erie County in the extreme northwestern corner of the state. No general survey has been made to determine definitely the presence or absence of this pest throughout the state as a whole, but it is probably safe to say that it occurs practically all over the state where peaches are grown. No attempt has been made to limit the distribution of this pest through quarantine measures, since in view of the fact that it is probably distributed largely in infested fruits originating not only in Pennsylvania but in other states to the southward, effective quarantine enforcement would be extremely difficult, if not entirely impossible, on account of the very general and extensive movement of peaches.

It is an outstanding pest of peaches and quinces especially, and also has been known to attack apples in some cases to a very considerable extent. Probably it is the outstanding peach pest of the present day, and as yet no really satisfactory measures of control have been developed. There is also some reason to believe that it may become a major pest of apple under some conditions.

IMPORTED WILLOW LEAF-BEETLE (*Plagiodera versicolora* Laich)

This European leaf-beetle attacking chiefly willows and poplar, is a rather recent introduction. It has been known to occur in the vicinity of Philadelphia for the past several years, having been noted by our nursery inspectors during the course of their regular inspection of nurseries for the first time in 1923. However, it had not been found beyond the immediate vicinity of Philadelphia prior to the summer of 1926, when it was found fairly abundant and doing considerable feeding on willows along the edge of the Susquehanna River in Harrisburg, approximately 90 to 100 miles distant from the infested sections around Philadelphia. While no general scouting has been carried on to

determine its presence elsewhere, it seems reasonably safe to assume that its spread from the westward and northward from the Philadelphia section has been rather slow, and probably does not occur to any extent beyond the territory mentioned.

While we have observed it to be feeding in comparatively large numbers and very extensively on willows, it can hardly be considered, as yet at least, as an important pest of either willows or poplars.

APPLE AND THORN SKELETONIZER (*Hemerophila pariana* (Clerck)

This European species first reported by Doctor Felt in 1917 had not been noted in Pennsylvania, as being of any consequence at least, prior to the summer of 1926. During the past summer it was found quite general in Wayne, Pike and Monroe Counties in the extreme northeastern corner of the state. A survey through this area showed it to be almost universally present on unsprayed apple trees, and causing very extensive, and in some cases complete defoliation. The fact, however, that it was found very largely on unsprayed apple trees, and seldom if ever on the trees that had received any reasonable amount of protection through arsenical sprays, would indicate that it should not be considered as a pest of major importance.

OBSERVATIONS ON THE LIFE HISTORY, HABITS AND CONTROL OF THE NARCISSUS BULB FLY, *MERODON EQUESTRIS* FAB., IN OREGON

By JOSEPH WILCOX and DON C. MOTE, *Oregon Agricultural Experiment Station*

ABSTRACT

The Narcissus Bulb Fly, *Merodon equestris* Fab., has been introduced into Oregon from Europe and has established itself in the commercial plantings of Narcissus. In one planting 14 per cent of the bulbs were destroyed by this pest.

Our observations to date show the seasonal history of this pest to be as follows: Winter is passed as full grown larvae in the bulbs. In March and the early part of April the larvae leave the bulbs usually through the neck and pupate in the soil, about ½ inch deep. The flies emerge mainly in April, but can be found in the fields until in June. Egg laying takes place in the latter part of April and in May. The majority of the eggs hatch in from 8 to 10 days and the young larvae enter the bulb usually through the basal plate. The larvae are full grown by September.

The injury by this insect is characteristic. The center of the bulb is eaten out and partly filled with brown excrement. Infested bulbs are not easily detected, and may be as hard and solid as uninfested bulbs.

All larvae in the bulbs can be killed by the Hot Water Treatment as applied for the Stem Nematode, *Tylenchus dipsaci* Kuehn. This treatment is not a cure-all, however, as it is impossible to remove all the bulbs from the soil when digging. Tests with ovicides made in the spring of 1926 were promising; 100 per cent control was obtained with corrosive sublimate.

The Narcissus Bulb Fly, *Merodon equestris* Fab., is one of the most serious insect pests of Narcissus both in this country and in Europe. This insect has been introduced into Oregon and now threatens the commercial Narcissus bulb industry, the plantings of which totalled close to 8 million bulbs in 1925 and are to be increased this season. A survey of the Narcissus plantings made in the spring of 1926 shows this insect to be established in practically all of the commercial plantings. In one planting 14 per cent of the bulbs have been destroyed by this pest in stock that has been grown only one year.

As there was little known of this insect in this country and especially in Oregon, it was found necessary to make a study of its life history, habits, and control under Oregon conditions. This study was started in 1925 and has been continued up to the present date. Practically all of the observations were made in several of the commercial plantings under field conditions.

Seasonal History

Observations to date show the seasonal history of this pest to be as follows: The winter is passed as full grown larvae in the bulbs. In March and the early part of April, the larvae leave the bulbs usually through the neck and pupate in the soil about ½ inch deep. The flies emerge mainly in April but can be found in the fields until in June. Egg laying takes place in the latter part of April and in May. The majority of the eggs hatch in from 8 to 10 days and the young larvae enter the bulbs usually through the basal plate. The larvae are full grown by fall. One generation is produced each year.

Life History and Habits

The Eggs are chalk white in color, oval in shape, and 1.6 mm long by .6 mm wide. Practically all the eggs are laid in the soil about the base of the plants. More than 400 eggs have been gathered in the fields, and in every case except one they were found in the soil. In the one exception the egg was deposited on a leaf about ½ inch above the soil. A number of flies have been observed while ovipositing and in no case was there an attempt to lay the eggs anywhere except in the soil. The position in the soil is usually about ⅛ inch deep and from ¼ to ¾ inch away from the plant. They are generally found attached to the under side of a small clod of dirt. Usually only a single egg is found to the plant but as high as four have been taken in the field.

Egg laying takes place in the latter part of April and in May. The first date on which eggs were found in the field was April 19, and the last date on which unhatched eggs were observed in the field was May 21.

The eggs hatch in from 6 to 15 days. Of the 43 eggs of which we have a record, 72 per cent hatched in from 8 to 10 days.

THE LARVAE or "grubs" when newly hatched are 1.8 mm long and are white in color. The short black posterior respiratory process is characteristic of the newly hatched as well as the full grown larvae. When full grown the larvae measure nearly ¾ inch in length, are quite robust and are a dirty yellowish color.

The newly hatched larvae in most cases enter the bulb through the basal plate but in a few cases they enter through the side at the neck or base. That this is the logical place for the larvae to enter the bulb can be gathered from the fact that the eggs are laid in the soil and the only part of the bulb that is not protected by several layers of hard tough skin is the basal plate.

The growth of the larvae is quite rapid. In June they are from ¼ to ⅜ inch in length; in the latter part of July they are ½ inch in length and by the middle of September they are practically full grown. The larval stage extends from May to March or a period of 10 months.

THE PUPARIA are from a light to dark brown color depending more or less on the type of soil in which they are found. Puparia taken from a planting in Red Hill soil were a brick red color. They are ½ inch long and have the short black posterior respiratory process and the two horn like anterior spiracles prominent.

The larvae leave the bulb usually through the neck but sometimes through the base and migrate into the upper inch of soil to pupate. The majority of the puparia were found in a horizontal position in the soil about ½ inch deep or just under the surface crust.

Pupation begins early in March and continues into April. Larvae were found in the soil evidently preparing to pupate on April 7. The first puparium was found April 13 and the last larva April 7. The length of the pupal stage varies from 18 to 34 days. The average length is 30 days. In a record of which there is some doubt, the duration of the pupal stage was 45 days.

THE FLIES are about ½ inch long and resemble a small bumble bee both in appearance and habits. The body is covered with hairs and they vary from entirely black to entirely orange. The four varieties described by Verral[1] and an additional variety have been recognized in Oregon.

In an outdoor cage the flies emerged over a period of about a month. The first fly emerged March 27 and the last flies April 29. Records

[1]Verrall, G. H. (1901) British Flies, Vol. VIII, Platypezidae, Pipunculidae, and Syrphidae. pp. 555–560. Pub. by Gurney & Jackson: London.

kept in one cage showed that the males were the first to emerge and were closely followed by the females. These emergence records are: April 12—1♂; April 15—7♂; 3♀; April 19—3♂; 6♀; and April 22—1♂; 4♀. The peak of the emergence was between the 10th and 20th of April; 9 flies emerged between March 27th and April 10th; 25 flies emerged between April 10th and 20th; and 8 flies emerged between April 20 and April 29th.

As the spring of 1926 was an early season, the emergence of the flies may be expected later than the above dates in normal years. Laboratory observations showed that the time of emergence of the flies was regulated by temperature as early emergence was obtained in the laboratory. The warm (70°F.) dry laboratory conditions were not favorable to the development of the flies, however, as out of numerous infested bulbs only the following flies were obtained: 1—Nov. 19; 1—Dec. 14; 1—Jan. 20; 1—Feb. 1; 1—Feb. 10; 2—Feb. 16; and 1—Feb. 17.

In flight the flies make a deep humming noise that is very similar to that of a bumble bee. This noise is evidently produced by the vibration of the wings in flight. The males fly quickly from place to place and usually rest on the tips of the leaves. At rest the males hold their wings at an angle of about 45° with their bodies. The females fly close to the ground and light on the leaves near the base. They frequently fold their wings together when at rest.

On cool and cloudy days the flies cannot be found in the fields, and are evidently away from the field feeding on flowers as they have been observed to be covered with pollen. For example on May 10 the morning was cloudy and no flies were seen in the field. At 10 o'clock the sun came out bright, and in a short time the flies appeared in large numbers and could easily be seen flying in and about the daffodils.

COPULATION. In only two instances have we noted the flies in copulation and in both cases the flies were at rest. The process was described in our notes as follows: "The male lights on the back of the female with his first pair of legs clasped on the forepart of her thorax, behind her head. He rapidly vibrates his wings all the while. After remaining there for half a minute he quickly moves back on her body so that his legs are clasped around her abdomen and the wing vibration stops. In a very short time their copulatory appendages are engaged and he begins to move his abdomen backward and forward rapidly. The female has her wings only as far apart as necessary or at an angle of about 30° with her body. In about one-half a minute the male begins to vibrate his wings and to make a high pitched buzzing note (there is no

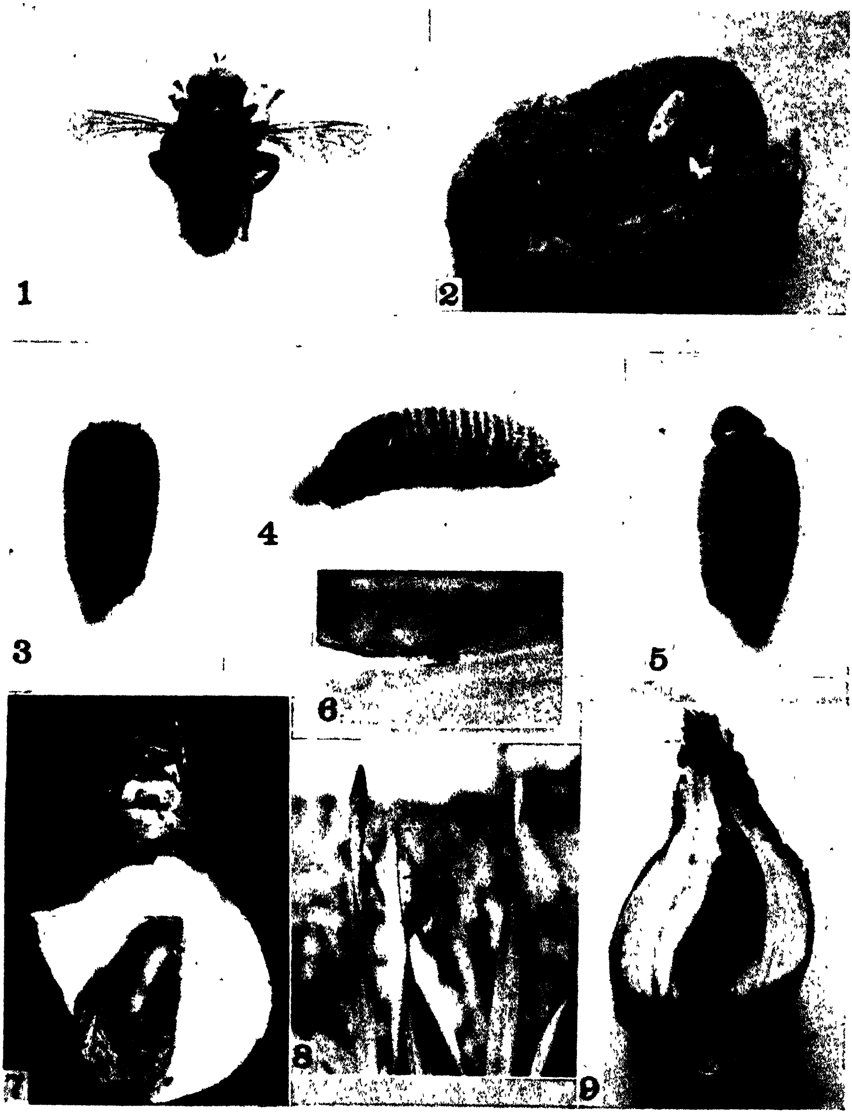
deep humming noise at this time). This continued for about 5 minutes until the flies separated. After a few minute's rest they copulated again, and in the course of an hour's time they were noted to successfully copulate 3 times and the male was unsuccessful in mounting the female on at least 3 other occasions."

The high pitched buzzing note made by the male is quite shrill and distinctive and seems to only be produced when attempting to copulate, while copulating, or when closely confined. It was determined by close observation that this note is produced only when the halteres are in rapid vibration; the wings at this time may either be in motion or at rest.

Oviposition was observed a number of times and only in the middle of the day when the sun was shining. The female fly lights on a daffodil plant about 5 inches from the ground and descends the leaf with her head pointed down and usually with her wings folded. Her ovipositor is partly extended and on reaching the ground she completely extends her ovipositor. She nervously moves about the base of the plant, working her abdomen up and down and probing in various places, evidently searching for a suitable place to deposit her eggs. From one to two minutes may be spent in this searching process. When a suitable place is found, usually under a small clod of dirt adjacent to the plant, she becomes perfectly still and the egg passes out in from 20 to 30 seconds. Immediately she leaves and flies upward and usually hovers in the air 4 or 5 inches from the ground foı a moment before flying to another plant to deposit another egg.

In some cases the fly rests between egg laying and diligently cleans her wings, the top of her thorax and the sides of her abdomen with her hind legs, and then rubs her tarsi together to clean these. She also cleans the side of her proboscis and face with her front legs. However, usually she flies from one plant to another and lays her eggs in rapid succession. They are evidently capable of laying a number of eggs in a short time as is illustrated by the following incident. At 12 o'clock, May 10, a female fly was captured in the field and confined in a cage over several plants. On the following day at 4 P. M. or 28 hours later, the cage was examined and the fly found dead. However, around the plants were gathered 56 eggs laid by this fly and there were no doubt others as they were difficult to recover from the soil.

The flies evidently prefer to lay their eggs in the shade, which accounts for the fact that most of the eggs are found in the soil on the north side of the plants. This has been observed in the field and is also illustrated by the following incident. Several flies were confined in a cage



Male Narcissus Bulb Fly; 2. Egg of Narcissus Bulb Fly (above) and three eggs of the Lesser Bulb Fly (below) as deposited on a clod of dirt; 3. Puparium, dorsal view; 4. Larvae, lateral view; 5. Dorsal view of puparium after fly has emerged, 6. Flies in copalation: 7. Dead larva and bulb mites in bulb given hot water treatment. Larva about ½ grown; 8. Male fly at rest on the tip of a Narcissus leaf; 9. Bulb showing typical injury; the full grown larvae have worked well up into the nose of the bulb.

over three plants in the field; when examined for eggs, the plant on the sunny side produced no eggs; the plant in the middle produced 5 eggs, and the last plant produced 7 eggs.

Injury

The injury caused by this insect is very characteristic. The center of the bulb is usually hollowed out and the flower bud consumed. The area around the larva is usually hollow but the remainder of the cavity is filled with excrement which is of a brownish color and resembles peanut butter both in color and physical makeup. Infested bulbs are worthless as usually they will not grow and when they do grow they produce only a weak leaf growth and no flower. The flower bud is not always destroyed but this is the usual case. Sometimes the splits may be attacked and the mother bulb free from infestation but it is usually vice versa. The bulb thus injured may produce a few small splits in a year's time but the bulb usually rots or is destroyed by mites, lesser fly, or fungus diseases.

Infested bulbs in the field are usually easily detected. All vacant spaces in the beds or rows should be regarded with suspicion and examined. When the bulbs do grow the leaf growth is spindly and yellowed. In one case an infested bulb was noted to blossom but the flower was wrinkled and did not open.

Contrary to common belief, the writers have not found it easy to detect infested bulbs after they have been dug. Large bulbs that are infested may be as hard and sound as uninfested bulbs. Numerous smaller bulbs have been destroyed by taking it for granted that they were infested because they gave under pressure of the fingers. The best method of determining whether a bulb is infested or not is to carefully examine the basal plate. Bulbs that have the basal plate sunken and corky are likely to be infested and a little scraping with a knife will reveal the entrance place of the larvae. Where entrance is made in some place other than the basal plate the bulbs can easily be detected as usually the hole is open and not plugged with the corky frass.

Control

The Hot Water Treatment as applied for the stem Nematode, *Tylenchus dipsaci* Kuehn, will kill all the larvae present in the bulbs. This treatment is not a cure-all, however, as it is impossible to remove all the bulbs from the soil when digging. Bulb growers are agreed that no matter how carefully you dig, 5 per cent of the bulbs are always left in the soil; thus leaving enough larvae there to infest the planting the following spring unless the planting is moved to some other locality.

This is the method that is being employed by some of the growers now. All the bulbs are dug each year, and all the stock is given the Hot Water Treatment, and then the treated bulbs are planted in a locality away from the older commercial plantings. All bulbs that are found to be infested at the time of digging are destroyed either by burning or by boiling in water.

Experiments conducted with ovicides on a commercial planting in the spring of 1926, gave promising results. The advantage of this treatment is that the insect is killed before the damage is done, while the Hot Water Treatment kills the insect after the damage is done and even then the grower is not assured that his crop will be free of infestation the following spring. The results of this experiment are given below:

TABLE 1.—FIELD TREATMENT FOR THE CONTROL OF THE NARCISSUS BULB FLY—1926*

Treatment	No. bulbs in plot	No. bulbs infested	% of bulbs infested
Dormoil 2%............	741	15	2.02
Corrosive sublimate 1 oz.–10 gal. water.....	816	0	0.00
White oil emulsion 4%...	681	46	6.75
Check—No treatment....	736	52	7.06

*Bulbs examined in August 1926.

Five applications were made, the solution being poured about the base of the plants. The first application was made April 23 and the last May 27. A more detailed account of this field test and the results of the same on the control of the Lesser Bulb Fly will be found in October, 1926, number of the JOURNAL.[2]

It is planned to continue the experiments with ovicides for several seasons so as to determine the effects of the treatment on the growth of the bulbs and on the control of the flies.

EXTENSIONS OF THE KNOWN RANGE OF EUTETTIX TENELLUS BAKER AND CURLY-TOP OF SUGAR BEETS

By WALTER CARTER, *Bureau of Entomology, U. S. Department of Agriculture, in cooperation with Idaho and Montana Experiment Stations.*

ABSTRACT

A severe outbreak of the sugar beet leafhopper (*Eutettix tenellus* Baker) during 1926, which caused heavy losses to the sugar beet industry in the intermountain region, was accompanied by a wide dispersal of the insect. This paper records observations made on the occurrence of the leafhopper and curly-top disease during

[2]Wilcox, J. (1926) "The Lesser Bulb Fly, *Eumerus strigatus* Fallen, in Oregon. Jl. Ec. Ent., Vol. 19, pp. 762–772.

a survey undertaken in cooperation with the States of Idaho and Montana and Canada to determine the new range of the pest.

The year 1926 proved a disastrous one for the sugar-beet industry in the intermountain region, owing to the severe attack of the sugar-beet leafhopper (*Eutettix tenellus* Baker). All indications are that the season has been one of general dispersion of the insect, and for that reason the arrangements made by the Bureau of Entomology for cooperative surveys covering the distribution of this species and its principal food plants in Montana, South Dakota, and Alberta, Canada, proved especially opportune. The results from South Dakota will be published separately. Some data from Wyoming collected by Mr. R. W. Haegele, of the Idaho Experiment Station, are included, as well as some from British Columbia near the Idaho boundary. The data are tabulated below.

Place	Date	Observer
Montana—Florence, Stevensville, Paradise, Charlos Heights Lolo, Plains, Ravalli, Charlo, Arlee, Dixon, Perma, St. Ignatius, Missoula.	August 17, 1926	J. R. Parker[1] and W. B. Maybee

All the above-mentioned places are in the Bitterroot Valley or in the vicinity of Flathead Lake, Montana. The records are for the insect only.

Canada, British Columbia—Rykerts, Kingsgate, Creston	August 10, 1926	
Wyoming—Green River, Rock Springs, Eden, Jackson Hole	September 29, 1926	R. W. Haegele[2]
Montana—Heron, Thompson Falls,	August 13, 1926	

Records for Wyoming are for *E. tenellus* only. Garden beets with typical curly-top symptoms were reported by this observer from Creston, B. C., and Heron, Montana. The specimens from Creston were tested by the writer by feeding individuals of non-infective *E. tenellus* on them and then transferring these to healthy beets. All these beets developed symptoms of curly-top in about 10 days.

Wyoming—Mammoth Hot Springs, Yellowstone National Park.	August 10, 1926	
Montana—Gardiner, Daly, half way between Gardiner and Livingston.		Walter Carter

[1]Montana Experiment Station.

[2]Idaho Experiment Station.

Above records are for *E. tenellus* only.

Montana—Billings and vicinity, August 30, 1926 Walter Carter

Two cases of curly-top suspected in beets in Great Western Sugar Co. territory. Specimens brought in to Twin Falls laboratory and tested gave positive results.

Montana—Bitterroot Valley, August 30, 1926 Walter Carter

Both *E. tenellus* and curly-top found on mangels.

Negative results were obtained in a survey made for *E. tenellus* by H. L. Seamans[3] on September 22, 1926 in the Province of Alberta, Canada, over an area bounded on the west by Cardston, Pincher Creek and Nanton, thence to Gleichen, and from Gleichen due east to the Saskatchewan boundary.

Discussion

The area covered by the Canadian survey comprises the most favorable territory in Alberta for breeding grounds of *E. tenellus*, considered from the standpoint of host-plant occurrence. The negative result of this survey, while not conclusive, is suggestive from the standpoint of possible limiting factors. The Bitterroot Valley records are interesting, as this valley offers an excellent opportunity for the study of limiting factors on the insect's range, since it is near the breeding grounds of the insect in Idaho.

The cases of curly-top recorded from the Billings district are the first on record for that territory. The root necrosis presented a peculiar appearance never observed in diseased beets in the Twin Falls area. On cutting through the diseased root, a black exudate oozed from the fibro-vascular bundles, which in a few minutes gave to the root the appearance of having been heavily inked.

The appearance of the insect on the east side of the Continental Divide in Montana is of much interest. Only occasional specimens could be found. Apparently 1926 was a year of general dispersal, and a reasonable interpretation is that these specimens represent the few straggling individuals which had survived a long-distance migration. The other interpretation is that they are native to that place, but, being at the edge of the natural breeding range, are few in number. No nymphs were to be found even after very close examination, and the writer is inclined to the first interpretation.

The appearance of the insect in areas separated from its natural breeding ground by high mountain ranges can not readily be explained by a teleological theory of migration. The insect is extremely small

[3]Dominion Entomological Branch (Canada).

and of light weight, and the slightest ground breeze will carry it for yards. It does, however, "migrate," and should it encounter strong winds it is quite conceivable that it might be blown into the upper air currents and by them be transported (in what must practically amount to cold storage, since these upper air currents are often of very low temperature) for very long distances.

The discovery of the insect east of the Continental Divide and of the two isolated cases of disease at Billings theoretically opens up that area as possible curly-top territory. Unless the insect is in process of rapid adaptation, however, this possibility is very remote, since there is no record of the insect successfully competing with weather such as is encountered in that area.

A MONTHLY SURVEY REPORT FORM

By J. A. Hyslop, *Bureau of Entomology*

Abstract

To better systematize and render comparable the notes on insect conditions throughout the United States received by the Insect Pest Survey in order that this information may be of use to future workers desiring statistical data, a report form listing the more important pests of each of the major agricultural regions of the United States with check columns for the various degrees of prevalence is presented. In conjunction with this form is a consideration of the several methods of unifying the conception of the various degrees of prevalence.

When the Insect Pest Survey was organized six years ago, there was no machinery for the collection of statistical data on entomology in this country, other than the localized surveys of a few States and sporadic surveys carried on here and there to ascertain the distribution of some particular insect.

The goblins of insurmountable difficulties were conjured up when this work was inaugurated and some of these in truth seemed to be very material beings. First, there was a very hazy recognition of the value of collecting data on insect abundance regardless of their quality; second, there was a general feeling that there would be an indisposition on the part of the field workers to take the trouble to send in observations; and third, there was the undoubted fact that no methods had been devised by which an observer could standardize his observations.

The first of these "insurmountable difficulties" has vanished into thin air. The symposium held in Cincinnati when the Survey was one year old brought out many interesting features regarding the methods of estimating insect abundance then in practice, but its outstanding feature was the general recognition by the entomologists that survey

work was worth while, and that methods of estimating insect abundance, which would render data comparable, were not unattainable. You all realize how the interest in this phase of entomology has grown in the past few years.

The second difficulty was more of a phantom than the first. From the very beginning the collaborators of the Survey *most willingly* "took the trouble" to send in notes; many, in fact, organized for this purpose and all have put forth a very decided effort to give the Survey each month as good a picture as possible of the insect conditions in the territory in which they are working. Each year the quantity and quality of notes have improved, each year additional states have organized for the work, until now practically every entomological agency in this country and Canada is working with a common purpose.

The last difficulty is still believed by the "conservatives" to be insurmountable. Quite true, at the present time we have but very few methods of estimating insect abundance that even fall within the bounds of statistical reliability. However, the Hessian fly workers have methods that are reasonably exact. Larrimer (Journal of Agricultural Research XXXII p. 1044) has shown that the probable error of a determination obtained by the methods used by his workers depends on the number of individuals examined and the percentage of infestation, and gives highly comparable figures.

It has been suggested that it is a waste of time to make general observations, even though these be made to the best of our present ability, until we know exactly the type of observation which will meet ideal statistical requirements. To my mind it would be folly to wait for exact knowledge of this character before doing anything, and such reasoning seems to me the veriest nonsense. Had Thomas Say waited to describe his first insect until the necessary information was at hand that would make his description complete for every detail that would be needed at any time in the future, he would have died without ever having described a species. The same would have been true of all subsequent taxonomists not only of the past, but of the present. Who would say that the old observations of the weather made with crude apparatus and very little knowledge of the succession of storms were not worth while? Of course it would be ideal, and would render our notes decidedly more valuable, if we could include every detail that might in the future throw light on the reason for the current condition. We believe, however, that we should not wait a single hour but that every observation that is made by a competent entomologist should be recorded and placed in a common repository where it can be examined

by future workers. And this we are doing. Who can tell us what the general situation was throughout the United States relative to any of our common pests in 1916? A few persons may remember some pest in which they were particularly interested over a necessarily limited region, otherwise that page of the entomological record is blank. However, from 1921 to the present time, the period over which the survey has functioned, we have a fairly definite picture of general insect conditions throughout the country for any year, or any month.

This much has been accomplished and we feel that we are now ready to take the next step forward in *Survey Work*, and that this and every successive step will be in the direction of more detailed and refined observation.

I shall present this evening an outline of a type of report which I believe will be a step in this direction and yet will not be so great a stride as to embarrass the field worker or add unduly to his work.

One of the outstanding weaknesses of our reports in the past has been the lack of negative data. Serious outbreaks are almost invariably reported, even unusual abundance is generally observed, but the absence of a pest or its decided reduction in numbers is usually overlooked. An exception to this is found in the many reports received this year on the marked decrease in numbers of aphids on deciduous fruits. We have also felt another weakness of a more involved nature, that is, the lack of uniformity in the conception of the prevailing degree of infestation in the case of most of our insect pests.

To limit the number of species upon which reports are to be made is an extremely hazardous procedure. Very often our most interesting notes on an insect are received from a region where this insect is not of general economic importance. The unusual occurrence of *Alabama argillacea* Hbn. in New England is far more interesting and may lead to conclusions on fundamental principles which never could be arrived at by observing this insect in its normal habitat. We do not wish any of our collaborators to feel that the report form which we are now proposing is in any way intended to take the place of the general and miscellaneous notes on all insects that come under their observation such as they have been sending in during the past few years. This new form should be considered as merely supplementary, and additional to the general reports. Of course it would not be necessary to duplicate notes on the insects which are covered by the report form, though such duplication would not be amiss. Rather than discontinue miscellaneous observations we would much prefer that you omit filling in the special report form.

The report form that I am presenting is arranged as a questionnaire. This necessitates limiting decidedly the number of species upon which reports are to be made. Now to limit the number of species involves, first, selection on the basis of relative importance. To name the three or four insects of first importance in any region is not so very difficult, the naming of the next six or seven, however, would be purely a matter of personal opinion and the same observer would include different species if he went from one region to another. We therefore conceived the idea of dividing the country into a limited number of natural crop regions, and selecting for each of these regions the 10 or 20 most important species.

You have all received my letter asking your opinion as to the most important insect pests of your state. The replies have been most interesting and enlightening. Fifty-one reporters representing 42 States have selected their 10 most important species, and in some States two or three collaborators sent in independent lists. You will note (Table 1) that in most of the regions there is a very decided uniformity of opinion as to the relative importance of the insects of that region, so I believe that our list very truly represents the relative importance of the insects as far as the economic entomologist is concerned. Of course it does not necessarily represent the *actual* economic importance of these pests. Undoubtedly over the Gulf region the mosquito is economically as important as the boll weevil, but it is not attracting the attention of the economic entomologist in that region to anywhere near the same degree.

Throughout the entire country the five species and groups of species attracting the most attention, arranged in the order of their importance, are the codling moth, cutworms, the corn ear worm, the San Jose scale, and grasshoppers. About 25 species of insects are of major economic importance throughout a large part of the United States, and about 50 species are of interest in three or more states. The remainder of our pests are of local distribution or at least local economic importance. Of the first 10 species selected by the entomologists as of most importance, 7 were among the 10 most frequently reported to the Insect Pest Survey during the past six years. This is very interesting, as it shows that the data we are receiving, even with our crude methods, are of decided statistical value.

Having picked the 10 or 20 species for each of the regions the second consideration with regard to this report form was to prepare a series of definitions which would remove as far as possible the personal factor in deciding upon the degree of infestation prevailing. For the present it

was felt that six degrees of differentiation would be as fine as should be attempted. Though we realize that percentages are often meaningless or nearly so, in survey work, we have, for convenience, laid out six degrees of abundance or damage as an index to abundance as follows: The first degree should be 0 and the last degree should be 100 per cent. The four intermediates should be from 1 to 20 per cent, from 21 to 40 per cent, from 41 to 60 per cent, and from 61 per cent to 80 per cent from which point the rather hazy 100 per cent should be recognized. Now, roughly, 0 per cent means that the insect is absent; 1 to 20 per cent means that the insect is present in negligible numbers; 21 to 40 per cent should cover what is usually spoken of as moderate abundance, 41 to 60 per cent should have the general significance of abundant; 61 to 80 per cent should mean very abundant; and 81 to 100 per cent should describe an epidemic. These generalized definitions are not easily translated into the terms of any given insect, each insect must be considered by itself, so we conceived the idea of defining for each of these insects each degree of infestation. That these definitions will have to be modified and changed, there can be no doubt; that they will make recorded observations more comparable throughout the entire country, is just as evident; that they will lead to a general improvement in the methods of estimating insect abundance I am confident.

That many insects can not be readily counted is evident, and the abundance of some of these can be best estimated by the effect they produce upon the host. For example, take the striped cucumber beetle. If it can not be found in the area surveyed, the insect is considered as falling in the first category. If a few beetles are observed but are doing no noticeable feeding, the infestation belongs in the second category. If feeding is noticeable and some injury to parts of the plant can be observed, but the plants in general are in good growing condition, the insect infestation is considered in the third category. If most of the plants are affected, and some of the plants are destroyed though a stand is still possible, the infestation is placed in the fourth category; if all or most of the plants show serious effects from the attack and a very poor crop is certain, the infestation is in the fifth category. If the crop is totally destroyed, we consider the infestation 100 per cent.

In addition to recording the degree of infestation we provide for recording the total area surveyed. The area may have been a single 2-acre cucumber field, it may have been one-half dozen fields in a township, it may have been five or six fields in the country, or it may have been a great many fields throughout the State. We further provide for recording the unit area actually examined; that is, whether 5 or 6 hills or

TABLE 1.—A TABLE INDICATING THE NUMBER OF STATES IN EACH GEOGRAPHICAL REGION WHICH PLACE THE GIVEN INSECT AMONG THE FIRST 10 IN IMPORTANCE IN THAT STATE.

	New England	Middle Atlantic	South Eastern	East Central	North Central	West Central	Lower Mississippi	Rocky Mountains	Great Basin	South Western	Pacific Coast	States	Reporters
Carpocapsa pomonella	4	7	2	5	1	4	2	2	2	1	3	33	40
Noctuidae	3	4		3	2	4	3	1	1		2	23	25
Heliothis obsoleta		3	3	3	1	4	6	1				21	23
Aspidiotus perniciosus	1	4	1	4		1	5		2		1	19	21
Acridiidae	2			3	2	3	2	2	2	1	1	18	21
Elateridae	3	3			2	1	1		2		2	14	15
Phyllophaga spp	2	2		2	2	3	1		1			13	16
Empoasca mali		3	2	3	3	1						12	13
Leptinotarsa 10-lineata	2	1		1	2		3	2		1		12	13
Conotrachelus nenuphar	3	5	2				2					12	12
Anthonomus grandis			4				6					10	12
Aegeria exitiosa		6	1	1			2					10	12
Phytophaga destructor		2		4		3						9	12
Blissus leucopterus				3	1	3	2					9	10
Diabrotica vittata	2	2		2	2	1						9	9
Anuraphis roseus	2	6										8	10
Calendra spp			1	2		1	4					8	9
Epilachna corrupta		2		2				2		1		7	9
Alabama argillacea		1	1				4			1		7	8
Rhagoletis pomonella	4	1		1								6	6
Phytonomus posticus								2	3		1	6	6
Psallus seriatus			1				5					6	6
Aphis pomi	2	1		2				1				6	6
Pyrausta nubilalis	1	2		2								5	9
Laspeyresia molesta		5										5	8
Pontia rapae				1	2			2				5	6
Cirphis unipuncta		1		2		2						5	5
Musca domestica		1		1		1	1				1	5	5
Sitotroga cerealella		4										4	5
Porthetria dispar	3	1										4	4
Culicidae		2		1		1						4	4
Lepidosaphes ulmi	1				1			1	1			4	4
Popillia japonica		3										3	5
Hylemyia brassicae		2			1							3	4
Illinoia pisi		1			1					1		3	3
Pissodes strobi	3											3	3
Diabrotica 12-punctata			1				2					3	3
Macrodactylus subspinosus	2			1								3	3
Termites				1		1				1		3	3
Malacosoma americana	1	1		1								3	3
Aphis gossypii						1	1	1				3	3

TABLE 1.—*Continued.*

	New England	Middle Atlantic	South Eastern	East Central	North Central	West Central	Lower Mississippi	Rocky Mountains	Great Basin	South Western	Pacific Coast	States	Reporters
Papaipema nitela........	2					1						3	3
Hylemyia antiqua........					2			1				3	3
Archips argyrospila......		1						1			1	3	3
Porosagrotis orthogonia....					2			1				3	3
Phlegethontius spp.......			1	1								2	2
Erythroneura comes.......		2										2	2
Diabrotica longicornis.....						2						2	2
Brachyrhinus ovatus......											2	2	2
Eriosoma lanigerum......											2	2	2
Anarsia lineatella........											2	2	2
Toxoptera graminum......					1		1					2	2
Epitrix cucumeris........	2											2	2
Rhagoletis cingulata......		1									1	2	2
Crambus spp...		1		1								2	2
Diatraea saccharalis......			1				1					2	2
Polychrosis viteana.......		1		1								2	2
Loxostege sticticalis.......								2				2	2
Aphis maidi radicis......				1		1						2	2
Eutettix tenella..........									2			2	2
Psylla pyricola..........		1										1	3
Iridomyrmex humilis.....							1					1	2
Chrysomphalus aonidum...			1									1	2
Eriophyes oleivorus......			1									1	2
Ephestia kuehniella......				1								1	1
Hylemyia cilicrura.......									1			1	1
Chrysomphalus aurantii...											1	1	1
Saissetia oleae...........											1	1	1
Sanninoidea opalescens....											1	1	1
Epitrix subcrinita........											1	1	1
Lecanium corylii.........											1	1	1
Forficula auricularia......											1	1	1
Eleodes spp.............									1			1	1
Pseudococcus gahanii.....											1	1	1
Coccus pseudomagnoliarum											1	1	1
Plathypena scabra........			1									1	1
Harmologa fumiferana....					1							1	1
Gryllus assimilis.........					1							1	1
Meromyza americana.....					1							1	1

plants were examined or 100 plants or hills, whether a square yard or 10 square yards of the field were examined, whether 50 or 60 feet of row were examined, and, should the species be an orchard pest, the number of trees and the method of selection.

Of course the degree of infestation varies decidedly in importance with the date and development of the plant. For example, with the alfalfa weevil 100 per cent infestation on the day alfalfa is to be cut is of but little importance to that cutting whereas a degree of infestation ranging approximately in our second category, three or four weeks before harvest, might very easily develop into 100 per cent infestation and the total destruction of the crop before the date of harvest. We therefore provide for recording the actual date of observation. If the survey is a broad one, of course it might be necessary to give the dates beginning and ending the survey. Lastly, we provide for recording the stage of plant growth; that is, whether the plant is in bloom, just sprouting, fully ripened, or otherwise.

To make it unnecessary for the reporter to remember the definitions for the several degrees of infestation for each insect, we propose printing the descriptions in pale blue ink in the place where the record is to be made and over which notations in lead pencil, black ink, or typewriting can be easily made. Thus the recorder will not have the trouble of referring to a key sheet.

Many species lend themselves very nicely to actual counting methods. For example, the Hessian fly can be actually counted in the larval and flaxseed stages, and the percentages of infested culms and the number of flies per culm recorded. In such cases, under the degree of infestation it will be desirable to write in the actual percentage observed; that is, if the percentage fell within the 21 to 40 per cent degree of infestation it will be desirable to note 38 per cent under that heading, if 38 per cent happened to be the percentage actually counted.

We realize that this type of report form is still very generalized and that, for certain insects, many of our collaborators are making much more detailed observations. We have therefore outlined a special form which, though intended to be sent in once a month, provides for weekly recording. Here a single card is provided for each of a very limited number of species. On this card space is provided for practically the same data as on the General Monthly Report Form previously described, but a separate series is set aside for all reports falling withn the first week of the month, another for the second week, another for the third, and one for the last week of the month.

To those who are carrying on intensive investigations of one or two important pests we would very strongly suggest that if you wish to do a great service for Economic Entomology you attempt to ascertain what an adequate sample of the insect in question is, and the range of infestation, in order that we may at some future time specify what the unit area should be for each insect and the distribution of these unit areas necessary for a given total area. Investigations along this line applying statistical methods to entomological observations can not but help very materially to advance the work of the Insect Pest Survey.

DISPERSION OF *COMPSILURA CONCINNATA* MEIG. BEYOND THE LIMITS OF THE GIPSY MOTH AND THE BROWN-TAIL MOTH INFESTATION

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Abstract

The following is a brief account of the attempt made to obtain data, and some of the results achieved, on the dispersion of the imported Tachinid, *Compsilura concinnata* Meig., beyond the limits of infestation of the gipsy moth and the brown-tail moth.

While *Compsilura concinnata* Meig. was confined to the areas in New England infested by the gipsy moth and the brown-tail moth, larval and pupal collections of these species were made in various localities each year to determine the relative increase and the dispersion of this parasite. Records also were obtained from collections of native larvae that were sent in from time to time by men employed in the field and by others interested in insect collecting. Only a few collections of native larvae were received from territory outside of the infested area.

By 1922 *C. concinnata* had spread beyond the known limits of the infestation of these two moths, so if further information on the dispersion was desired other means had to be adopted.

In the study being made of the native species that are being attacked by the introduced parasites, we have recorded over one hundred that are suitable hosts of *C. concinnata*. It has been learned also, that during August was the best time for collecting the greatest variety of suitable host larvae.

It was decided, therefore, that a trip by automobile should be made through a section of country outside of the known infested area, especially to collect larvae that are known to be suitable hosts. The first trip, made in August, 1922, and covering a period of three and one-half days of collecting, was successful; as a result, similar trips embracing larger areas have been made each year since.

An idea of the territory to be covered was made up beforehand, but it was understood that availability of good roads was to determine the exact route. Two men traveled together in a touring car, taking along a good supply of mailing tubes for the collections. One man drove, while the other watched for infestations or suitable places in which to collect. Attempts were made to obtain collections at least every ten mi'es, and at more frequent intervals if material could be found. Usually only one species was placed in a mailing tube, but occasionally, to save tubes, a few small collections were combined. A note was enclosed in each tube, giving the date, locality, species collected, food plant, the abundance, and the name of collector. As soon as a large town was reached all the accumulated material was mailed to the laboratory at Melrose Highlands, Mass.

The accompanying map shows the location of recoveries of *C. concinnata* outside of the area infested by the gipsy moth, and the routes taken on collecting trips. It will be noted that the collecting was done for the most part in a westerly direction from the area infested by the moth. In Maine, beyond the points of colonization and recoveries of this parasite, no attempt was made to obtain larval collections until 1925. Many collections from Long Island, New York, west to the Delaware Water Gap, and south through the area in New Jersey infested by the gipsy moth have been received since the moth was discovered and the extermination work begun there in 1920.

In 1921 *C. concinnata* was recovered from native larvae collected at (4)[1] Garrison, N. Y., (34) Greenport, N. Y., and (7) Castleton, Vt. These localities were outside of the area known to be infested by the gipsy moth at that time. In 1922 several collections were sent by field men to the Melrose Highlands laboratory from the northern section, and the collections from the vicinity of New York City and southward were taken care of at the Somerville, N. J., station.

At first there was some doubt about obtaining enough suitable host material to make a trip worth while; the first trip was therefore made through a section from which no larval collections were being received, and where it was felt that the possibilities of recovering *C. concinnata* were greatest. Four recoveries were made from material collected on this (1922) trip.

During the summer of 1923 recoveries were made from native larvae sent in from (9)Shawangunk, N. Y., (8) Salem, N. Y., (3) Armonk, N. Y., (33) Brooklyn, N. Y., and (22) Swanton, Vt., by men connected

[1]The numbers correspond to those on the map and indicate the location of towns mentioned.

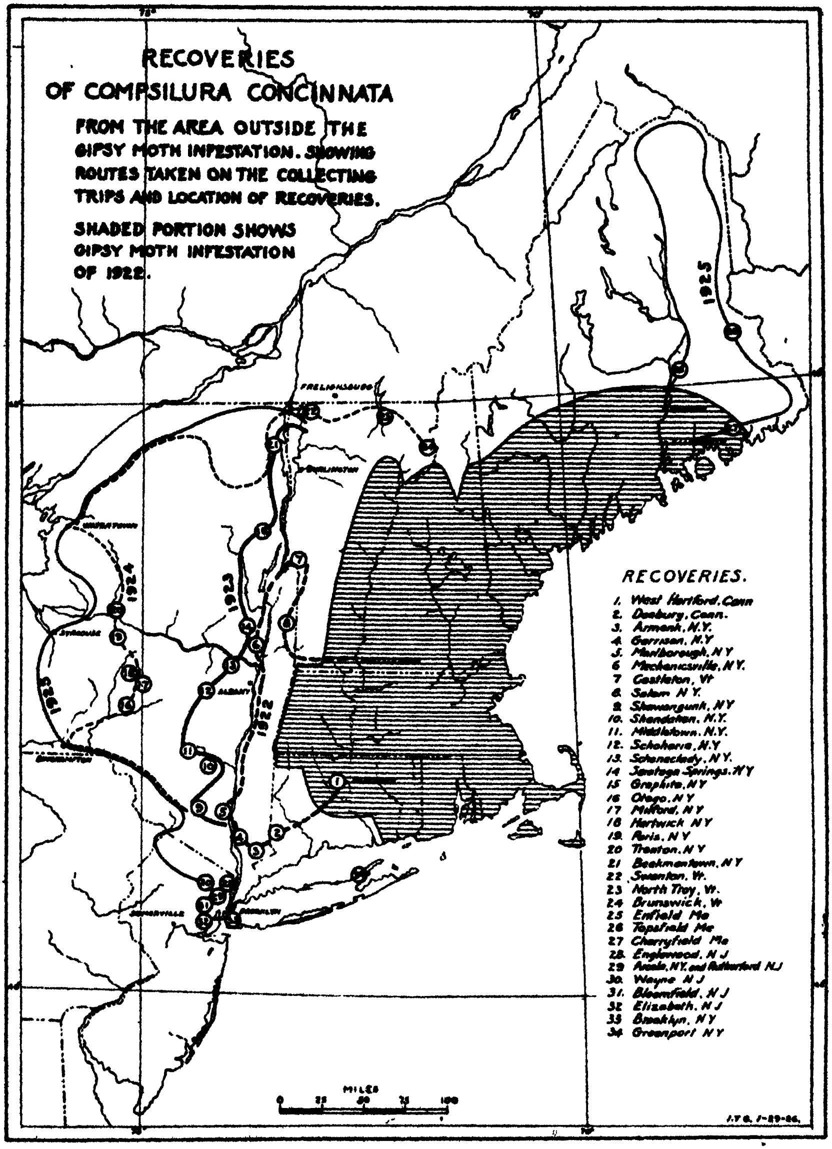


FIG. 25.—Map showing recoveries of *Compsilura concinnata* Meig. from the area outside the Gipsy Moth infestation (Prepared by I. T. Guild)

with the New York Conservation Commission and the U. S. Bureau of Entomology. Consequently, the 1923 trip was planned west and north of points of these recoveries, and, as a result, seven recoveries were made from six localities.

In January, 1924, L. S. McLaine, Chief of Division of Foreign Pests for the Canadian Government, in a letter to A. F. Burgess, in charge of Moth Work, reported the recovery of *C. concinnata* from material collected at Freleighsburg, Quebec.

The trip in 1924 was made west of the Catskills and Adirondacks, also through sections of northern New York and Vermont, covering areas from which no larval collections were being received. *C. concinnata* showed up in collections from eight localities.

In 1925, through the co-operation of the New Jersey Department of Statistics and Inspection, collections of native larvae were sent in from New Jersey by the nursery inspectors. As the result of these collections, and of some sent in by field men of the U. S. Bureau of Entomology, six recoveries of *C. concinnata* were obtained from five localities in the northeastern part of the state, namely (28) Englewood, (29) Arcola, (31) Bloomfield, (32) Elizabeth and Rutherford. No collections were received from the northwestern part of the state; the trip for 1925 was therefore planned to include this section and the northeastern corner of Pennsylvania, thence north to the Liberty Highway, along the Liberty Highway to Binghamton, and northerly through central and northern New York. It was planned to obtain, if possible, larval collections from 25 to 50 miles beyond the localities where previous recoveries of *C. concinnata* had been made.

It was deemed advisable to procure native material this year (1925) from eastern and northern Maine, and four and one-half days were spent collecting larvae in that section. Three recoveries have been made from Maine and one from New Jersey, as the result of the 1925 trips. A considerable amount of insect material was picked up on these collecting trips. Miscellaneous larvae were taken, whether or not the particular species had been recorded as a host of *C. concinnata*.

The table on the following page lists the host material collected, and the recoveries from it of *C. concinnata*. Unidentified larvae, and those not recorded as hosts of *C. concinnata*, are omitted from this list.

HOST MATERIAL AND RECOVERIES OF *Compsilura concinnata*

	No. of Collections				Number of Larvae				No. Recoveries of Compsilura			
	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925
Aglais milberti Godart......	0	0	0	2	0	0	0	340				
Anisota rubicunda Fabr.....	0	0	1	1	0	0	73	11				
Anosia plexippus L.......	8	3	13	0	23	4	66	0				
Anisota senatoria S. & A ...	0	0	3	3	0	0	490	384				
Apatela americana Harr....	0	0	0	3	0	0	0	10				
Apatela furcifera Guen....	1	0	0	0	1	0	0	0				
Autographa brassicae Riley...	1	0	0	0	8	0	0	0				
Automeris io Fabr..	8	8	1	2	16	28	1	2	1			
Basilarchia sp..	0	0	0	1	0	0	0	1				
Callosamia promethea Dru.	1	1	1	1	9	3	1	6				
Cimbex americana Leach...	0	0	2	6	0	0	9	32				
Cingilia catenaria Dru... ..	0	1	0	0	0	3	0	0				
Datana angusii G. & R......	0	0	0	1	0	0	0	82				
Datana integerrima G. & R.	0	0	0	1	0	0	0	109				1
Datana ministra Dru....... ...	0	8	21	27	0	374	1648	1217		5	5	
Datana perspicua G. & R...	2	0	0	0	53	0	0	0				
Diacrisia virginica Fabr.....	3	1	1	2	3	2	1	2				
Epargyreus tityrus Fabr.....	17	14	3	6	194	225	5	100	1			
Estigmene acraea Dru.........	2	1	4	4	4	3	4	4				
Euchaetias egle Dru.........	9	9	9	10	242	319	425	501	2	1		
Euvanessa antiopa L.......	0	1	3	9	0	89	282	955			1	
Evergestis straminalis Hubn..	0	0	0	1	0	0	0	67				
Halisidota caryae Harr........	1	5	11	9	1	105	913	15			2	

	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925
Halisidota maculata Harr....	0	1	6	20	0	3	48	498				
Halisidota tessellaris S. & A..	13	13	3	2	37	26	22	5				
Hemerocampa leucostigma S. & A.........	3	1	0	4	3	11	0	126				
Heterocampa species......	0	0	1	3	0	0	1	148				
Hydria undulata L..........	1	0	0	2	90	0	0	162				
Hyphantria cunea Dru.....	0	2	4	0	0	436	390	0				
Lycia cognataria Guen........	0	2	1	6	0	2	1	7				
Mamestra ligitima Grote....	0	0	1	0	0	0	1	0				
Mamestra picta Grote.......	0	0	0	3	0	0	0	13				
Melalopha inclusa Hubn.......	0	0	0	2	0	0	0	250				
Nadata gibbosa S. & A......	0	0	0	1	0	0	0	1				
Neurotoma fasciata Norton...	0	0	0	1	0	0	0	208				
Notolophus antiqua L......	0	1	0	4	0	1	0	54				
Paonias excaecatus S. & A..	0	0	0	4	0	0	0	6				1
Papilio polyxenes Fabr........	1	0	0	0	1	0	0	0				
Papilio troilus Linn........	1	0	0	0	10	0	0	0				
Papilio turnus Linn........	0	1	1	1	0	1	1	1				
Pheosia rimosa Packard.....	0	1	0	0	0	1	0	0				
Pholus pandorus Hubn.......	1	0	0	0	1	0	0	0				
Polygonia comma Harr........	0	1	0	0	0	6	0	0				
Polygonia interrogationis Fabr	0	0	0	7	0	0	0	130				
Pontia rapae Linn........	1	0	0	1	60	0	0	75				
Samia cecropia Linn........	0	1	1	0	0	1	1	0				
Schizura concinna S. & A......	0	13	22	58	0	596	2091	2788		1		2

Schizura unicornis S. & A. . .	0	1	0	1	0	1	0	1				
Scoliopteryx libatrix Linn. . . .	0	0	0	1	0	0	0	1				
Sphinx chersis Hubn.	0	0	0	2	0	0	0	3				
Sphinx gordius Stoll.	0	0	2	0	0	0	2	0				
Symmerista albifrons S. & A. .	0	0	0	4	0	0	0	159				
Telea polyphemus Cram.	1	0	1	0	1	0	1	0				
Thanaos sp.	0	1	0	0	0	2	0	0				
Vanessa atalanta Linn.	3	0	0	0	7	0	0	0				
Totals	78	91	116	216	764	2242	6477	8474	4	7	8	4

In the table below are listed the locations of recoveries of *Compsilura concinnata* from native larvae collected outside of the area infested by the gipsy moth and the year each of these recoveries was made:

RECOVERIES MADE AS THE RESULT OF COLLECTING TRIPS

1922	1923	1924	1925
(1) W. Hartford, Conn.	(10) Shandaken, N. Y.	(16) Otego, N. Y.	(25) Enfield, Me.
(2) Danbury, Conn.	(11) Middletown, N. Y.	(17) Milford, N. Y.	(26) Topsfield, Me.
(5) Marlborough, N. Y.	(12) Schoharie, N. Y.	(18) Hartwick, N. Y.	(27) Cherryfield, Me.
(6) Mechanicsville, N. Y.	(13) Schenectady, N. Y.	(19) Paris, N. Y.	(30) Wayne, N. J.
	(14) Saratoga Sprgs., N. Y.	(20) Trenton, N. Y.	
	(15) Graphite, N. Y.	(21) Beekmantown, N. Y.	
		(23) North Troy, Vt.	
		(24) Brunswick, Vt.	

RECOVERIES FROM MATERIAL SENT IN BY STATE EMPLOYEES AND BY FIELD MEN OF THE BUREAU OF ENTOMOLOGY

1921	1922	1923	1924	1925
(4) Garrison, N. Y.	(No recoveries)	(3) Armonk, N. Y.	(No recoveries)	(28) Englewood, N. J.
(34) Greenport, N. Y		(8) Salem, N. Y.		(29) Arcola, N. J.
(7) Castleton, Vt.		(9) Shawangunk, N. Y.		(31) Bloomfield, N. J.
		(33) Brooklyn, N. Y.		(32) Elizabeth, N.J.
		(22) Swanton, Vt.		(29) Rutherford, N. J.

Since the discovery of the gipsy moth in New Jersey in 1920 many hundreds of native larvae from that state have been reared. Until

1925 no recoveries of *Compsilura concinnata* were made except in the immediate vicinity of points of liberation in the moth-infested zone. The recoveries in 1925 from the northeastern part of the state indicate that this parasite is very common there. For example, one collection of 27 larvae of *Euvanessa antiopa* Linn., from Elizabeth, produced 57 individuals of *C. concinnata*.

Apparently this parasite is spreading westward more rapidly than it is southward. From the results achieved, it appears to have worked its way westward through the country south of the Adirondacks, and around or over the Catskills. In the past two years an abundance of material was collected west of the Adirondacks, but without results so far as this parasite is concerned. However, the fact that this species was not recovered from collections made in various localities does not necessarily mean that it is not present there.

The recoveries in the localities farthest west prove that this parasite has at least spread to points approximately one hundred miles west of the known limits of the gypsy moth infestation, and that it thrives on native hosts without the presence of the gipsy moth and the brown-tail moth, for the control of which it was introduced.

It is also of interest to note that the principal hosts of *C. concinnata* outside of the area infested by the gipsy moth and the brown-tail moth are often pests of considerable importance, and there is no doubt that this parasite acts as a check on many of them.

HOW SHALL WE IMPROVE THE MEETINGS OF OUR ASSOCIATION?

EDITORIAL NOTE: For several years criticisms have been made regarding the arrangement of programs, time allowed for presentation of papers, sectional divisions with overlapping sessions and other matters. With the marked increase in membership and the usual activities of the members, a larger number of papers are scheduled for each succeeding meeting, and the situation becomes more and more acute. The usual remedies suggested are: more sectional meetings, decreasing the time of each paper, and presenting abstracts in place of papers.

The following paper by Professor Roger C. Smith is so filled with constructive suggestions that we print it here, hoping to bring out other plans, and comments and criticisms from the members. In order to have the benefit of all such plans and discussion, in preparation for the forthcoming meeting at Nashville, Tennessee, please send your opinions at once to the Associate Editor, W. E. Britton, Chairman Program Committee, Agricultural Experiment Station, New Haven, Conn.

A PLAN TO FACILITATE THE ANNUAL MEETINGS OF THE VARIOUS SECTIONS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE WITH SPECIAL REFERENCE TO THE ENTOMOLOGICAL SECTIONS[1]

By Roger C. Smith, *Professor of Entomology, Kansas State Agricultural College.*

The overcrowded condition of the programs in many of the sections of the American Association for the Advancement of Science is a subject of wide comment. As a result of this condition, the discussion of papers is either prohibited or severely limited, either by necessity or by common consent. The writer has been impressed too by the small amount of authentic information about papers presented, brought back from the meetings by many folks, unless notes were taken at the meeting. Very few hearers take notes, however. It is a matter of agreement that the most important reasons for attending these meetings are the meeting of folks you have heard about, whose papers one has read, or of old friends. Since most of the papers will be published and may then be read, the papers are of second interest but of real importance. To offset the crowded programs, the various societies are dividing into smaller groups, so there may be several to a half dozen groups in one's particular field in session at the same time. It is, therefore, utterly impossible to hear many papers given, or to meet as many people as one might wish by attending the meetings. These facts, together with an acknowledgment of the value of exhibits and that membership in the various sections is gradually increasing, are the reasons for suggesting a new plan.

The Plan. It is suggested that papers be presented on the exhibit plan and that the regular sessions become largely discussion meetings. A person having a paper to present would notify the Secretary, as at present, and would be assigned a place at a table, possibly an improvised one, in some room. He would then be entitled to have the first carbon copy of his paper placed there, with the abstract or summary on top, saving the original copy to send to the editor. Tables of data and plates of drawings would be hung on the wall above or arranged in some conspicuous position in the space allotted. He may show specimens or microscopical preparations with the aid of suitable apparatus. Chairs or stools might be made available. The lighting would have to be adequate. The spaces would be assigned in the same sequence as the papers appear on the program, thus allowing the present commendable plan of grouping papers of related subject matter.

Members and visitors could then pass along this row of exhibits at their convenience, reading summaries, examining the papers as much

[1]Contribution No. 361 from the Entomological Laboratory, Kansas State Agricultural College.

as they desired. Illustrative material might be examined first hand. It would be desirable to have designated by the author on a card at each space a period or the periods, preferably before the session in which the paper is called, in which he may be at his space to discuss the work with others. These exhibits would be in charge of an elected assistant secretary who would see that they were properly placed, before the first session of the meetings, to keep them in order and to return the exhibits to the authors. He would be given authority to appoint an ample committee to assist him, which in most cases could be most profitably made up of members who live near where the meeting is to be held.

Regular sessions would be held for discussion as is now done, except that the papers would not be read. The author would read his abstract or make comments on the work, being strictly limited to three to five minutes when his paper is called. If there is no discussion, no questions or contributions to the subject at hand, the next paper is called. To save further time, persons to be called upon at each session might take seats at the front of the room.

It is believed with this plan that the sessions may be reduced in number and in length, for perhaps many papers of restricted interest would pass without comment. The remainder of the time would then be available for visiting, discussing matters in groups, or, what is still more important, examining the offerings of members of other sections. The exhibit rooms would be kept open all day and during at least a part of the evening, so that persons might be accommodated over a long period of time. Papers and exhibits of authors not attending the meeting and papers now read by title would be assigned to spaces, but they would not be called in the session. Provision could also be made for papers completed too late to be listed on the program, but such papers need not be called in the regular meeting, except by action of the society. The program of the association should be distributed before the meetings so that visitors could plan their time to best advantage according to their special interests.

Advantages. The big advantage and aim of the plan is to save time and increase the efficiency of the meetings. This would most certainly result. Those attending the meetings could get all the information they wished about papers on work in their particular field regardless of what particular days they attended the meetings. They could give the papers more attention than when they are given orally. Members and visitors should, therefore, bring away from the meetings far more information about the work, and it would be accurate. Microscope slides and actual material exhibited will greatly clarify the subject under discussion.

Many times an examination of this material alone would be all that would be necessary. Persons would pass along the row of exhibits, stopping to read summaries and examining material as they wished. Contributions of members not in attendance would be available for examination and likewise papers now read by title. It would not be necessary to be present at all of the different sessions of the various societies to find out what is going on in various fields of research. The various contributions with illustrative material would be available for examination during the whole meeting, including evenings. Older members whose time is now largely taken up by committee work could examine the contributions and bring home a more adequate idea of the work of the year as represented by them. In fact, it would allow an increase of committees and caucuses for the discussion of specific problems, a laudable and very desirable arrangement. It would encourage the preparation of high grade illustrative material, such as good slides, good mounts, drawings, photographs and charts. One would get many practical suggestions on the preparation of such materials.

Because of the saving in time effected, the number of days a section needed to be in session could be reduced. Individuals might effect a saving in personal expenses for attending the meetings. It would allow the increase of sessions for symposia and invitation addresses in fields of general interest without unduly influencing the length of sessions. This method is capable of accommodating a greatly increased membership, thus doing away with the splitting off of sections or divisions. It is fair to all. No one need be slighted nor cut down because of brevity of time, even if his paper comes at the first or last sessions when attendance is smallest. His work would be available to all during the entire session.

Disadvantages. No plan is without some disadvantages. The following are all the disadvantages which occur to the writer or have been suggested to him by his associates.

1. This plan would involve some expense. Papers and illustrative material would have to be sent to the assistant secretary or some member of his committee before the meeting and returned to the authors after the meetings. Postage and express charges would be incurred and the return cost borne by the societies. Improvised tables might have to be prepared, involving some expense for lumber and carpenter work. Perhaps some lighting changes would be necessary. Some microscopes and binoculars would be needed. Perhaps the number available locally would be insufficient. Since the assistant secretary would have to spend

several days before the meetings arranging the exhibits and about the same length of time putting things in order after the meeting, a portion, at least of his expenses should be paid. The increased cost is the most serious criticism of the plan. It usually costs money to save time. Perhaps an exhibitor's fee of fifty cents or a dollar could be charged as is now commonly done at fairs and many other kinds of exhibits. The expense could be held down to an inconsiderable sum, however. Many authors would take their exhibits home with them. The lumber used would be little or not at all damaged and would be taken back by the lumber company with perhaps only a delivery cost.

2. Could rooms of sufficient size be obtained in which to arrange these papers and illustrative material? It would be desirable to have all the papers of a section in one room. There might be some difficulty here also. Usually the meetings are held in either high school or college buildings. Laboratories of sufficient size would generally be available. The ideal situation the writer believes would be to arrange the papers and exhibits of all the sections of the entire association at one place. Usually the city auditorium or Memorial Hall could be made available and would provide sufficient space. One could then examine the contributions of other sections without loss of time. Some special lighting arrangements would be necessary for the use of any microscopes and binoculars used under such conditions.

3. There might be some loss of material, filching of slides or damage to microscopes. Possibly, yes, but probably the loss would be very slight. Various societies have had exhibits in a small way for years and such losses have not occurred, to the writer's knowledge. There might be some damage to microscopes unless they were fastened to the tables. Special arrangements to show slides by high power or oil immersion would be necessary to prevent injury to slides and objectives.

4. One would miss the personality of the writers in reading the papers for ones self. But opportunities are provided by this plan to meet the writers of papers face to face and to see them taking part in the discussion on the floor.

5. Papers would lose much of their force, for a well-delivered paper compels your attention. But many papers are poorly given, and in some cases the papers are really better than one thinks after hearing them delivered. Forcefullness in delivery should not be necessary to get interest in scientific work. Scientists are accustomed to judging work by the data presented. High pressure salesmanship should not be necessary.

6. Folks would not examine papers you say. We listen to some papers in sessions which we would not hear if we did not hesitate to leave the session, and are perhaps broadened thereby. This is a doubtful benefit. Since the papers are available for examination, the same information may be obtained from it or its author at one's convenience and if the program is crowded, a paper may be omitted for more important matters. The amount of good derived from the meetings under the present plan depends upon the seriousness and activity of those attending.

7. But some papers presented to the meetings are not in final form. In fact, some have not yet been written. This plan requires the finished paper. Should a paper be presented before it is in final form? Often new ideas, different interpretations, discovery of weaknesses, etc., are made during the preparation of work for publication. The writer believes that ordinarily papers should not be presented until they are finished. A brief announcement of important discoveries and very significant observations can be made, however, in abstract form, the abstract being given a place the same as a paper. This provision alone would aid in reducing the crowded programs.

8. If one must be contented with reading the papers, why go to the meetings, for practically all will be published, and they can then be read. The advantages now gained by attending the meetings would all be retained—meeting folks, hearing of work before it is published, gathering of information, personal stimulation, etc. The reader will have the advantage of seeing the specimens or microscopical preparations upon which the work of many papers is based. Published plates showing these are always less satisfactory than the actual material. One may meet the author and discuss this or other work with him and with others.

CONCLUSION. While this plan is not now used, at least in entirety, anywhere, to the writer's knowledge, yet its feasibility seems clear. The difficulties and valid criticisms as the writer sees it, are additional expense and certain mechanical difficulties which are however not serious. The success of the exhibits of the American Society of Zoologists at the recent meetings presages the success of this plan, which is largely an extension of that method. Authors of papers could not be expected to spend much time at their exhibits else they would miss the advantages of the meetings. This plan would solve many of the problems arising out of the present congestion and would take care of a considerable increase in membership. The meetings of many sections have reached the stage where a change in plan or policy with reference to program now seems imperative. The meetings should not be mere endurance contests, but

real opportunities for broadening one's knowledge, increasing acquaintances, and for personal inspiration. The proposed plan provides these with increased efficiency.

SCUTIGERELLA IMMACULATA NEWPORT, A PEST IN GREENHOUSES

By Glenn W. Herrick

Abstract

The Symphylid, *Scutigerella immaculata* is a serious pest to Snapdragons in greenhouses in Nyack, N. Y. The organism is widely distributed over the United States and has been reported as injurious to various vegetable crops. It is now known to occur in eastern and western New York. A solution of miscible carbon disulphide shows promise of destroying the pest in the soil of the greenhouse beds.

Early in February, 1927, "a little white insect" was reported to the author as very injurious to snapdragons in greenhouses about Nyack, N. Y. Later in the same month, I was able to get some specimens of the "insect" at work on the plants and found it to be an Arthropod resembling a centipede and clearly not of the class, Hexapoda. On further study it proved to be the rather interesting Symphylid, *Scutigerella immaculata*. One correspondent wrote that this was the first year that the pest had appeared but that it was threatening them with the loss of a considerable part of their stock. Another correspondent said that the pest had been troubling them in their greenhouses for several years. Interestingly enough they said that "we have found out that these insects are only in the solid benches. When we change the soil about the middle of June or the month of July these insects go to the bottom of the benches where it is moist. When we put the new soil in, these insects come right back in the soil we put in. But in the raised benches they cannot live, because the benches dry out and without moisture they die. But we grow our Snapdragons in the solid beds because they grow better than in the raised beds."

We were not able to visit the infested greenhouses at the time the pest was reported but later I had an opportunity of doing so. Nyack proved to be a center of snapdragon production and several greenhouses in the city grow nothing but this one flower for the New York City market. In one form of bed, called the "solid bench," the soil is placed on the ground in concrete retaining walls from 12 to 24 inches high, while in the other type of bed the soil is placed in wooden benches about eight inches deep and some three feet from the ground. The symphlyids become troublesome only in the solid ground beds. Apparently the high wooden beds are too dry for these moisture-loving animals to maintain themselves.

The greenhouse owners have the practice of changing the soil in the beds every year in late June or July. The earth is removed from the beds and transported to a near-by field where it is allowed to lie for two years undergoing a process of aeration and rejuvenation. At the end of two years, the soil is considered in fit condition to use again for one season in the beds. In an examination of the soil in one of the fields in which the earth is dumped, and from which soil for the beds is obtained each year I found the *Scutigerella* present. Evidently the animal exists out-of-doors throughout the year and is transported back and forth from the greenhouse to the field and in the opposite direction when the beds are filled.

The animals feed on the roots of the snapdragons so severely that the plants are stunted while the flowers remain small and less attractive. Three crops of flowers are expected from the solid beds but when the Scutigerellas are numerous not more than two crops can be obtained and the flowers of these are of second-rate quality.

The first record of economic injury by this animal in the United States was made by Woodworth in California in 1905, where it was injurious to asparagus in the vicinity of Sacramento. In 1912–'13 its biology and injuries were studied by E. R. deOng in California and in 1924, F. H. Wymore published an article on this species in the Pomona College Journal of Entomology and Zoology, Vol. 16, p. 73, entitled "Biology and Control of the Garden Centipede."

The organism has been reported from Mass., Ky., Ohio, Ga., Col., Utah, Calif., and Oregon. In the "Weekly News Letter concerning Insect Pests and Plant Diseases" of the Departments of Entomology and Plant Pathology of the New York State College of Agriculture for July 18, 1927, Mr. M. N. Taylor of Erie Co., reports that *Scutigerella immaculata* "has cleaned up practically all vegetation in this area of land. A trap crop of lima beans was planted to attract the Symphylids. What corn that was not destroyed was treated in the hill with cyanogas." The organism is probably widespread over the country and will become increasingly evident. In Utah it has been reported as the most serious pest to truck crops, while in Oregon it is considered very injurious. In addition to asparagus, it has been found attacking lima and common beans, vetch, peas, roots of sugar beets, fleshy roots of corn, alfalfa, wild lettuce and some other plants.

Control

One of the greenhouse owners at Nyack is trying a miscible solution of carbon disulphide in an attempt to destroy the pest in the solid beds.

She is using the material at the rate of one gallon to 100 gallons of water and with this solution she is drenching the earth which has just been brought in from the field and placed in the beds. On one bed, about 160 feet long and 3 feet wide, she used 100 gallons of the diluted mixture. After an interval of about twelve hours we (six of us) spent an hour in forking over and examining the soil in this treated bed. We found many dead individuals but much to our surprise and satisfaction not a single living one. The odor of the carbon disulphide was still strong in the soil. It is probably too much to hope that the pest was actually exterminated from this bed for we could easily have missed here and there a living individual but certainly a very large percentage of the tiny organisms was destroyed—enough, perhaps, to hold them in check until the crop is produced. In a similar bed treated with the solution at one-half of the above strength, we were able to find about one living individual to three dead ones—quite enough living ones to provide for an infestation in time to interfere with the production of a full crop of flowers.

Scientific Notes

Second Brood of Plum Curculio (*Conotrachelus nenuphar*) **Reared in Illinois.** In connection with the discussion on the necessity of including poison for Curculios in late peach sprays, the following record may be of interest. On May 18, 1927, wormy drop peaches were placed in cages under peach trees at Carbondale, in southern Illinois. By the first week in July adults had emerged and were caged on peach trees with uninfested peaches. When it was evident that these peaches had become wormy they were transferred to flower pot cages in the insectary. On August 20 adults of the second generation began emerging.

S. C. CHANDLER, *Ill. State Natural History Survey.*

Occurrence of Hessian Fly in Colorado. During late July the County Agent of Sedgwick County in northeastern Colorado reported that losses were being incurred in numerous wheat fields in the eastern part of the county by the falling of the wheat. An investigation by the junior writer revealed an infestation of Hessian Fly, *Phytophaga destructor* Say. The infestation was found to extend along practically the entire eastern border, and westward into the county for at least 15 miles. In several of the fields as high as 10 to 12 per cent of the wheat was down. However, three per cent of the wheat down was about an average for the infested area. This is the first infestation to be found in the State.

GEORGE M. LIST and GEORGE S. LANGFORD, *Office of the State Entomologist, Fort Collins, Colorado.*

Oak pill gall, *Cincticornia pilulae* O. S. Pin oak leaves badly deformed by this insect were received early in August from Wm. M. Bullitt, Louisville, Kentucky, and believed to be ruining the trees, which were standing in a double row on each side of a roadway and had been set about fourteen years. Some of the oaks were badly

affected, showing a scanty, pale foliage and others were practically unharmed, this latter indicating a decidedly local habit. Many of the leaves submitted for examination had from twenty to thirty moderate sized to rather large galls, not a few leaves were greatly reduced in size, and occasionally little was visible except masses of galls almost completely hiding the normal leaf tissue. Conditions in the tops of the trees appeared to be even worse. The owner stated that the appearance of the trees was ruined and he was fearful that they would be destroyed. The infestation was much more general and severe than anything previously recorded in connection with this species.

E. P. Felt

A Stationary Spraying System. An experiment which has been watched with much interest by fruit growers in New Jersey and adjoining States, has been made by Mr. Charles Repp, of the John Repp Ice & Cold Storage Co., of Glassboro, N. J., to solve the high cost of spraying.

Mr. Repp has installed in one of the orchards a stationary spraying outfit. A 13,000 gallon tank is the water supply, and this is connected to a tank of 300 gallons capacity in which the spray material is mixed. This latter tank is placed immediately above another one of the same capacity and connected with a plug. When the material in the top tank is mixed the plug is removed by a man, and the solution enters the lower tank to be pumped through the orchard. It may almost be said that the mixing is a continuous process.

The pumping station has three Friend four-cylinder pumps which maintain a pressure of five hundred pounds. These pumps are worked by means of a belt attached to a tractor, and are arranged so that in the event of a breakdown of one of the pumps it can immediately be cut out of the circuit. The pumps are connected to ½" piping that has been laid throughout the orchard together with a return pipe of ¾" which prevents the pressure rising too high.

The distance between each row of piping is 360 feet, and each pipe connects with a plug or faucet equipped with a special clip, so that the hose can be clipped on easily, obviating the necessity for clamps and bolts.

From each faucet 200 feet of hose is run out. At the extreme end of this stationary outfit, a distance of 3,800 feet of piping, the pressure is 500 lbs., the same as at the pumping station, and this with nine lines of hose out at one time.

Mr. Repp has put on several sprays this season by this method and is well satisfied with the results. The obvious advantages are greater speed of application (100 acres of apples are covered in 3 days, whereas with the spray wagons it took 8 days), and the condition of the soil for the early spring sprayings can be entirely disregarded.

The cost of such an outfit compares favorably with that of a good spray wagon, for sufficient piping, the actual installation of the piping, tank and pump for a 30 acre orchard would cost only $1150.00.

C. F. Greeves-Carpenter, F.E.S.,
Philadelphia, Pa.

SUMMARY OF VOTES IN RECENT AMERICAN REFERENDUM ON DR. POCHE'S THREE PROPOSITIONS TO CHANGE THE INTERNATIONAL RULES OF ZOOLOGICAL NOMENCLATURE

Referring to the recent referendum on Dr. Poche's (Vienna, Austria) three propositions in regard to the Rules of Zoological Nomenclature, the undersigned has the honor to report to the zoological profession the following results of the ballot—

Poche's proposition I: 8 votes for; 549 votes against.

Poche's proposition II: 4 votes for; 550 votes against.

Poche's proposition III: 4 votes for; 551 votes against.

A detailed report will be made to the Tenth International Zoological Congress (Budapest) and the undersigned unreservedly accepts the unambiguous results of this referendum as definite instructions from the profession in the United States for him to cast his vote (in the Congress as delegate, and in the Commission as member) against all three propositions.

C. W. Stiles, *Professor of Zoology,*
U. S. Public Health Service

ROCKY MOUNTAIN CONFERENCE OF ENTOMOLOGISTS

The Fifth Rocky Mountain Conference of Entomologists was held in Pingree Park, August 15 to 20. A total of 56 persons registered at the College lodge, including members of the families of the entomologists in attendance. Thirteen states were represented, in addition to two representatives from Washington, D. C.

Chas. T. Vorhies, Tucson, Ariz.; Otis Wade, Lincoln, Nebr.; R. L. Webster, Pullman, Wash.; J. W. McColloch, Manhattan, Kans.; J. S. Houser, Wooster, Ohio; Wm. P. Hayes, Urbana, Ill.; W. H. Larrimer, Washington, D. C.; George G. Schweis, Reno, Nev.; Ernst Artschwager, Washington, D. C.; F. E. Whitehead, Moscow, Idaho; W. E. Shull, Ames, Iowa; George I. Reeves, Salt Lake City, Utah; F. T. Cowan, Billings, Mont.; C. H. Gilbert, Laramie, Wyo.; Miriam A. Palmer, Carl A. Bjurman, George S. Langford, C. P. Gillette, R. G. Richmond, John L. Hoerner, Sam C. McCampbell, George M. List, C. R. Jones, W. J. Morrill, (Head of Department of Forestry, C. A. C.), all of Fort Collins, Colo.; R. L. Wallis, La Junta, Colo.; M. K. Riley, Denver, Colo.; J. H. Newton, Paonia, Colo.; and A. E. Beardsley, Greeley, Colo.

The following list of subjects will give an idea of the programs given at the different sessions during the week. In addition to the subjects mentioned, there were of course a number of informal discussions that were said by many to be a very important part of the conference.

Soil Entomology—J. W. McColloch.

The Potato Flea Beetle in Washington—R. L. Webster.

Flea Beetles in Colorado—John L. Hoerner.

Symposium; History of Economic Entomology—Leaders: C. P. Gillette, W. P. Hayes, R. G. Richmond, G. S. Langford.

The Alfalfa Weevil—George I. Reeves; discussed by J. H. Newton, Geo. G. Schweis and F. E. Whitehead.

The Cherry Curculio—George M. List.

Keeping the Colorado Potato Beetle Out of Southern Idaho—F. E. Whitehead.

The Little Red Cattle Louse—W. E. Shull.

Plant Physiology and Insect Injury—Ernst Artschwager.

The Feeding Habits of Grasshoppers—George S. Langford.

Airplane Dusting—J. S. Houser (Illustrated by slides and two motion pictures loaned by the U. S. Bureau of Entomology).

Arsenites in the Control of the Mormon Cricket—F. C. Cowan.

The Work of Forestry Students in Pingree Park—W. J. Morrill.

European Corn Borer—W. H. Larrimer and J. S. Houser (Illustrated by motion pictures).

The Oriental Peach Moth—J. S. Houser.

The European Corn Borer: Large Scale Control Experiment—W. H. Larrimer.

The Caucasian Bees—R. G. Richmond.

The Honey Bee and Red Clover—R. G. Richmond.

The Potato Scab Gnat—J. S. Houser.

Mill Inspection in Kansas—W. P. Hayes.

Jackrabbit and Other Animal Life in Arizona—C. T. Vorhies.

The officers elected for the ensuing year were C. P. Gillette, Fort Collins, Chairman; J. W. McColloch, Manhattan, Kansas, Vice Chairman; George M. List, Fort Collins, Secretary; C. R. Jones, Fort Collins, Treasurer.

It was the consensus of opinion that the meeting next year should be held at about the same time and at the same place. A more complete report of the meeting is being mimeographed and will be sent to those who have attended the Conference at different times, or to any others requesting it.

George M. List, *Secretary*

SUMMER MEETING OF THE NORTH EASTERN ENTOMOLOGISTS

The Summer Meeting of the North Eastern Entomologists was held August 17, 18 and 19 in the form of a Field trip through the orchard districts of South Eastern Pennsylvania, Western Maryland, Eastern West Virginia and Western Virginia.

At Gettysburg on the evening of August 17, the party had an informal meeting and were welcomed into the state by R. G. Bressler, Deputy secretary of Agriculture of Pennsylvania. Mr. R. H. Bell, Director of Pennsylvania Bureau of Plant Industry also gave a brief talk, Dr. T. J. Headlee of New Jersey brought before the party the advisability of having a paper reading session of the North Eastern Entomologists. This subject was discussed by other members present and it was decided that the subject be presented again before the trip was over.

On August 18 the party visited the Entomological field station of Pennsylvania State College at Arendtsville where they were shown orchard trials of bait pails in control of the Oriental fruit moth together with laboratory equipment. Work in grub proofing forest nursery seed beds under the directions of Pennsylvania Bureau of Plant Industry were seen at Mont Alto State Forest Nursery.

In Maryland an apple orchard was visited in which a dust program was carried out. Near Hancock, Maryland, demonstrations were made of spray equipment for apple orchards and grading and washing equipment for packing of apples. In an evening session the Entomologists met with the Horticultural Society of Western Maryland at which time the assembly was addressed by Dr. R. A. Pearson, President of the University of Maryland; Dr. A. L. Quaintance, United States Department of Agriculture, gave a summary of the spray residue situation together with methods of removal; and Dr. S. W. Frost spoke on Oriental fruit moth control.

In West Virginia the cooperative packing shed and Entomological field station at Inwood were visited. The station's chief service is furnishing information for the

orchard spray service. The Mexican bean beetle in both larval and adult stages together with damage to bean leaves was exhibited.

At the Entomological field station at Winchester, Va., a demonstration was given of the behavior of Virginia and Colorado strains of codling moth. In some sprayed apples it was found that less than 1% of the Virginia moths were able to enter the fruit, while 26% of the Colorado strain made a safe entrance into the fruit. A check showed that 46% of the larvae were able to enter unsprayed fruit. Approximately 13% of the first cross entered the fruit. Orchard tests of summer applications of Vlock in 2% solution were shown. In the same orchard plots showing the use of various correctives to prevent burning from arsenate of lead and lime sulphur were shown. Gypsum and lime were checked, one against another. In the same orchard plots showing the control of apple blotch by the use of a Bordeaux mixture on North Western Greenings were seen. In another orchard various arsenicals were given tests in both light and heavy applications.

The party was welcomed into Virginia by Mr. Bell representing the Chamber of Commerce and by Mr. Glass who welcomed the party in the name of the fruit growers. At this meeting there was further discussion of the matter of a paper reading session, and the following motion was carried:

"That the Chairman appoint an executive committee of five, to include the present chairman and the chairman for 1928, for the purpose of working out the form and method of procedure looking toward affiliation of the Northeastern Entomologists with the American Association as a branch; also that the preliminary voting be conducted by mail in order that the proposal may be submitted to the American Association at the next annual meeting."

The Chairman appointed the following men to serve on this committee: Dr. T. J. Headlee, Chairman; Mr. A. F. Burgess, Prof. P. J. Parrott, Mr. V. I. Safro, 1506 Walton Avenue, New York City, and Prof. E. N. Cory, College Park, Md. (Prof. Cory to serve in place of Prof. Schoene.)

The following persons were present: A. F. Burgess, Melrose Highlands, Mass.; J. G. Sanders, Philadelphia, Pa.; R. H. Bell, Harrisburg, Pa.; P. D. Sanders, College Park, Md.; Marie Timmins, McSherreystown, Pa.; M. S. Slade, Biglerville, Pa.; H. T. Abercrombie, New York, N. Y.; J. R. Stear, Chambersburg, Pa.; F. J. Schnerderhan, Winchester, Pa.; C. R. Willey, Richmond, Va.; Herman Gerkon, Woodlawn, Baltimore, Md.; E. W. Greger, Glenside, Pa.; J. L. Horsfall, Yonkers, N. Y.; C. C. Hamilton, New Brunswick, N. J.; Mr. and Mrs. L. A. Stearns, Ironton, Ohio; W. J. Schoene, Blacksburg, Va.; L. P. Detman, College Park, Md.; William Middleton, East Falls Church, Va.; Thomas J. Headlee, New Brunswick, N. J.; R. A. Pearson, College Park, Md.; G. F. MacLeod, State College, Pa.; G. W. Underhill, Richmond, Va.; M. P. Zappe, New Haven, Conn.; H. S. McConnell, College Park, Md.; Henry W. Reiblich, Agatha A. Reiblich, Woodlawn, Baltimore Co., Md.; L. E. Dills, Inwood, W. Va.; H. E. Hodgkiss, State College, Pa.; L. M. Peairs, Morgantown, W. Va.; L. M. Berthalf, J. W. Bulger, J. L. Webb, Washington, D. C.; W. S. Hough, Winchester, Va.; Neale F. Howard, Columbus, Ohio; T. C. Shinghiff, J. Walter Englar, New Windsor, Md.; S. W. Frost, Arendtsville, Pa.; E. N. Cory, College Park, Md.; T. L. Guyton, Harrisburg, Pa.; A. L. Quaintance, L. M. Benhalf, Washington, D. C.; F. W. Poos, Norfolk, Va.; L. J. Bottener, Vienna, Va.; Wallace Colman, Washington, D. C.; W. S. Abbott, A. G. Kenyon, W. N. Davidson, and T. J. Schnederham, Vienna, Va.; K. E. Dills, Inwood, W. Va.

The Hudson River Valley was chosen as the meeting place for 1928. Prof. P. J. Parrott was elected as President; M. D. Leonard, Secretary.

ENDOWMENT FUND NEWS

The committee on endowment will publish from time to time the latest news under this heading in the Journal.

At the last annual meeting of the Association it was voted on recommendation of the Committee on Policy, that the President appoint a committee to take charge of raising an endowment. It was also voted that life membership fees might be paid in installments that could be spread over a period of five years. (See p. 14–15, Journal of Economic Entomology, Vol. 20, No. 1, February 1927.) President Harned has appointed the following committee to take charge of this work: A. F. Burgess, Chairman, George A. Dean and J. G. Sanders. It is desired that every member shall do all in his power to make this effort a success.

Need For an Endowment

During recent years the membership of the Association has grown steadily until more than 900 are now enrolled. The Journal of Economic Entomology which is owned and operated by the Association is being constantly enlarged, the number of printed pages having increased 42% during the past six years.

The work required to handle the details incident to enlarged membership and increased scope of publication is becoming so heavy that within a few years the Association will face a serious situation unless provision is made to adequately care for these needs. This condition together with the proper care of the finances is important but does not represent the most vital needs of the organization.

Entomology is expanding rapidly and with this expansion it is becoming more specialized each year. This is causing entomologists to establish more intimate contacts with other sciences and with the business world. Such developments are logical and will continue and increase as time goes on.

If this Association is unable to hold the interest and allegiance of the entomologists throughout the country and by so doing speak with authority for the science it represents, a general breakdown will result and the elements that should be held together will gradually shift about and affiliate with other activities. What is necessary is a strong unified organization capable of coordinating and holding the interest of specialized fields as they are developed. Progress along these lines requires unceasing toil and careful planning and will soon become so complex that the best results cannot be properly secured without a permanent organization.

We are approaching this condition of affairs and provision should be made without delay to meet the situation in advance of urgent need. The Association is of great value to entomology as a common meeting ground for both State and Federal workers and for all entomologists interested in insect problems. Its usefulness can be greatly increased with material benefit to all concerned.

A fund of $200,000 or possibly more will be necessary to afford sufficient income to maintain a permanent establishment and do effective work. The committee will invite one member from each State and each Province of Canada to organize the members in his own territory in order to make this effort a success. Each member is urged to do his utmost to assist the district representative and the committee.

A. F. Burgess, *Chairman*

FORTIETH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Nashville, Tenn., December 27 to 31, 1927

The 40th annual meeting of the American Association of Economic Entomologists will be held at Nashville, Tenn., on the above-named dates.

The schedule for the program has been arranged as follows:

Tuesday, December 27, 9:30 a. m., Section of Plant Quarantine and Inspection; 1:30 p. m., same section, program continued; 3:00 p. m., Section of Apiculture.

Wednesday, December 28, 9:30 a. m., Section of Apiculture, continued; 1:30 p. m., Opening Business Session of the General Association and Address of the President; 7:00 p. m., Entomologists Dinner.

Thursday, December 29, 9:30 a. m., Session of the General Association; 1:30 p. m., Joint Session of General Association and Cotton States Branch; 8:00 p. m., Meeting of the Extension Entomologists and Insect Pest Survey.

Friday, December 30, 9:30 a. m., Session of the General Association; 1:30 p. m., Session of the General Association.

Saturday, December 31, 9:30 a. m., Session of the General Association, including final business.

Headquarters for the entomologists will be at Hotel Hermitage, Nashville. Rates as follows:

Single rooms.................	\$2.00, 2.50 and 3.00 in the Open Court;
Single rooms..................	\$3.50 and 4.00 on the outside of the Bldg.;
Double rooms	\$4.00 and 4.50 in the Open Court;
Double rooms.................	\$5.00 and 6.00 on the outside of the Bldg.

All rooms have private bath.

There are quite a number of outside rooms that are connecting, each with private bath, and each containing twin beds. The rate on these rooms are \$2.50 per person, two persons to the room. There are also large rooms available which accommodate 3 or more persons where a rate of \$2.00 per person is quoted.

We are advised by the management that it will be impossible to let but few single rooms, so would advise that members registering either make previous arrangements to double up with someone or be prepared to arrange such on arrival at the hotel.

It is advisable that members expecting to attend the meeting make their reservations very early so that we can have as many entomologists as possible quartered in the hotel headquarters. I understand that other societies intend to make this hotel their headquarters.

Members desiring to submit titles for the program of the general sessions are urged to present subjects which are of broad, general interest. At the last meeting it was voted that papers be presented in concise form rather than in detail. The time will be limited to **5 minutes.** This will give more opportunity for general discussion. All titles must be in the hands of the Secretary not later than **NOVEMBER 10.** This will make it possible for the program to be printed and appear in the December number of the Journal to insure its distribution before the meeting. Members are requested to prepare and submit with their title an abstract of three or four printed lines indicating the facts contained in the paper, so that it can be included in the program. A longer abstract should be submitted with the paper for publication in the Journal.

In that the opening business session usually requires considerable time, it is recommended that Chairmen of Committees submitting reports make them brief—so as to save as much time as possible.

Application for membership should be filed as soon as possible and must be accompanied by fee of \$4.00. Blanks can be secured from the Secretary or from the chairman of the membership committee.

If you intend to present a paper at the meeting, **please forward the title promptly.**

R. W. HARNED, President,
A. & M. College, Miss.

C. W. COLLINS, Secretary,
Melrose Highlands, Mass.

October 1, 1927

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

OCTOBER, 1927

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

One hundred separates or reprints at $1.50 per page or plate. Additional hundreds or less, 4 pages or less, $1.00; 5–8 pages, $1.50; 9–12 pages, $1.75; 13–16 pages, $2.00; 17–24 pages, $3.00; 25–32 pages $4.00. Covers suitably printed on first page only, 100 copies, or less, $4.50; additional hundreds, or less, $1.75. Plates inserted, $1.75 per hundred or less. Folio reprints, the uncut folded pages (50 only), sixteen page signature, or less, $3.00. A discount of 10 per cent and 20 per cent from the above prices will be allowed on orders of 500 and 1000 reprints respectively.

The annual meetings are an exceedingly important part of our professional activities. They serve as a general clearing house for information and do more than any other agency to promote mutual understanding—a necessity to efficient cooperation. This last is imperative in a group dealing with the exceedingly varied and complex matters falling within the province of the economic entomologist. Special attention is therefore called to the discussion of methods of improving our meetings given elsewhere. The subject is worthy of very careful study. It is probable that no one man can offer an entirely satisfactory plan for bettering conditions. It is hoped that all will study the plan outlined by Professor Smith and take up the discussion in a friendly spirit leading to constructive modifications of our present plan, if such be possible.

The fundamental problem is one of publicity and in the case of our meetings, the aim is to acquaint professional colleagues with the latest developments. There is not time, there never can be time, to give all the details. There are too many investigators, too many lines of work in economic entomology, to make this possible. The judge of a court insists upon a brief and the higher the court, the briefer must be the brief. Our annual meetings are in a way the court of last resort. Let us submit briefs adapted to conditions. These may be vocal, written or even exhibits. There is no one method equally applicable to the results obtained by all workers.

Another phase of publicity is becoming more acute as time passes, namely publication facilities. The JOURNAL is the official organ of the

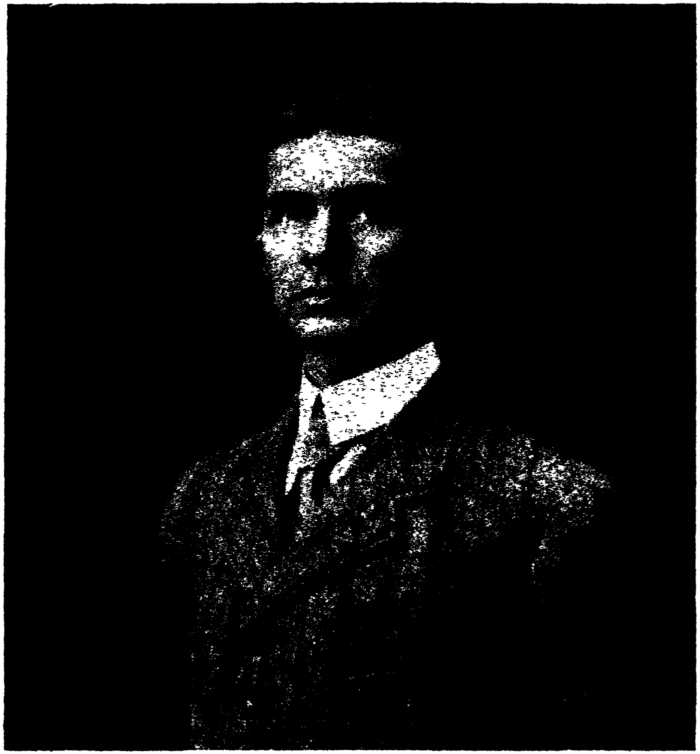
Association and as such publishes the annual proceedings. These, notices of branch and sectional meetings and papers presented at these require a constantly increasing amount of space. Not all the papers read by title at the last meeting can be published in this or earlier issues. The independent papers are at an even greater disadvantage and it is usually necessary to hold them a number of months, more than a year in some cases. Not a few authors have found it necessary to meet personally the cost of matter over-running our six page limit. A few papers have been printed without delay when the author was able to arrange for meeting the entire cost of publication of the matter. The obvious remedy would be more money for publication and early printing would in a measure aid in solving the program difficulty of the annual meeting.

Obituary

CHARLES FULLER BAKER

Charles Fuller Baker, entomologist, botanist, agronomist, collector, teacher, agricultural director and dean, died at St. Luke's Hospital in Manila, Philippine Islands, on July 22, 1927, aged fifty-five years. According to word received from D. L. Crawford, "his death was due to chronic dysentery which became acute and confined him in the hospital for two weeks before the day of his death." It is a comfort to his friends to know that during his illness he was attended by one of his own students, Doctor Leon Gardner of the Sternberg Hospital in Manila. He was buried on the campus of the University of the Philippines where he spent the last nine years of his arduous life. He was born at Lansing, Michigan, March 22, 1872, the second son in a family of ten children, and was the brother of the noted author, Ray Stannard Baker, and the forester, Hugh Potter Baker.

At the Michigan Agricultural College, from which he graduated in 1892, he came under the instruction of Prof. Albert John Cook who exerted a profound influence upon his studies in entomology and botany as well as upon many of his later activities in life. Prof. Cook once told me that Baker, when a student at college, spent all of his cash for insect boxes and by the time he graduated he had several hundred boxes of specimens, a larger and more complete collection than was at the college at that time. As an undergraduate he assisted Prof. Cook from 1891–1892 when he was transferred as assistant to Prof. C. P. Gillette at the Colorado Agricultural College, Fort Collins, Colorado.



CHARLES FULLER BAKER

The portrait on the left was taken during his stay at Pomona College, Claremont, California in 1909; that on the right on the celebration of his fifty-third birthday, March 22, 1925, when he was at the University of the Philippines, Los Banos, P. I.

Here he made very extensive botanical and entomological collections and began publishing. One of his first important contributions was "A preliminary list of the Hemiptera of Colorado"[1] in co-authorship with Prof. Gillette. Most of his earlier papers dealt with the Homoptera and particularly the Cicadellidae. It was in this publication that he described the sugar beet leafhopper, *Eutettix tenellus*, as *Thamnotettix*.[2] In 1893 he was in charge of the Colorado foresty and zoological exhibit of the Columbian Exposition at Chicago. The years 1897–1899 were spent partly in Alabama where he acted as zoologist in the Alabama Polytechnic Institute and entomologist in the Agricultural Experiment Station. Here he was connected with the Alabama Biological Survey. During 1898–1899 he was botanist on the H. H. Smith[3] exploring expedition in the Santa Marta Mountains, Colombia. In 1899–1901 he was a teacher of biology in the Central High School at St. Louis, Missouri. Following this he studied with Prof. Vernon L. Kellogg at Stanford University where he obtained the degree of Master of Science in 1903.

Through the efforts of Prof. Cook, Baker was induced to accept the position of Assistant Professor of Biology at Pomona College in 1903, but he remained there only one year. During this year he edited Invertebrata Pacifica[4]

He left California to become Chief of the Department of Botany of the Cuban Experiment Station (Estación Agronómica), Santiago de las Vegas, Cuba, which position he held from 1904 until 1907. During this very busy period also he published two very important papers on the then little known fleas of North America.[5] From Cuba he went to Brazil to assume the position as Curator of the Herbarium and

[1]Bul. No. 31, Tech. Ser. No. 1. Colorado Agr. Exp. Sta., Ft. Collins, Colo., 137 p. 1895.

[2]The generic position of this insect is still questioned by systematists.

[3]Celebrated entomological explorer and collector.

[4]This serial appeared as follows: Homoptera, Vol. 1, p. 1–12, Sept. 15, 1903; Orthoptera, p. 13–16, Nov. 30, 1903; Diptera, p. 17–40, Feb. 10, 1904; Hymenoptera, p. 41–70, Aug. 26, 1904; Orthoptera, p. 71–84, Jan. 30, 1905; Neuropteroid Insects, p. 85–92, May 15, 1905; Hymenoptera, p. 93–110, Aug. 20, 1905; p. 111–132, Oct. 27, 1905; Heteroptera, p. 133–140, Jan. 24, 1906; Hymenoptera, p. 141–159, May 24, 1906; p. 161–178, Feb. 28, 1907; p. 179–198, Oct. 8, 1907. It was begun at Claremont, Calif., and completed (p. 71–198) during his stay at Santiago de las Vegas, Cuba. It contained descriptions of insects which he collected personally, mostly in Califronia and Nevada. A part of his insect collection containing types and paratypes of many of these is at Pomona College along with many exotics collected in Cuba and Brazil.

[5]Rev. Am. Siphonaptera. Proc. U. S. Nat. Mus., Vol. 27, p. 1–365, 1904. Classification of N. A. Siphonaptera. Ibid., Vol. 29, p. 1–121, 1906.

Botanical Garden, Museu Goeldi at Para, where he stayed one year. In Brazil he amassed very large collections of both plants and insects which were presented to Pomona College upon his return there in 1908. It was at the beginning of my junior year in college there that I came under his singular guidance. With the enthusiasm, confidence and untiring cooperation of Prof. Cook, he accomplished a remarkable piece of work at that institution. His influence upon students was very unusual and he stimulated the most backward to produce surprising results. Many things,—equipment, housing facilities, money, were needed to supply him. These were secured by Prof. Cook, either directly from the College or from private individuals. Entomology at once forged ahead of all other biological sciences. Systematic and life history work became fundamental. For the citrus fruit growers of the region a system of orchard inspection was organized which gave not only excellent field experiences, but remunerative employment for advanced students, and rich returns to the growers. During his four years' stay there he inspired, trained and sent out a fairly large group of biologists in consideration of the small size of the institution at that time.[6]

Early in 1909 he explained to Prof. Cook the great need of serial publications, not only as an outlet for the work of students and specialists, but also for the benefit of all interested in the biological sciences, especially entomology and botany. Prof. Cook at once agreed and undertook, single-handed, to raise sufficient money by private subscription to finance first a Journal of Entomology[7] and then a Journal of Economic Botany.[8] The former appeared in March 1909, and the latter in February 1911. Another notable contribution was the publication of the First Annual Report of the Laguna Marine Laboratory[9]

[6]Among this group were Charles W. Metz, J. E. Graf, D. L. Crawford, B. L. Boyden, C. F. Stahl, H. J. Ryan, F. R. Cole, A. R. Davis, John A. Prizer, R. S. Vaile, A. R. Baird, H. A. Weinland, Harry V. M. Hall, Gertrude Bacon (Mrs. H. L. Chaffee), Vinnie E. Stout (Mrs. B. P. Aborn), Blanch E. Stafford (Mrs. Charles W. Metz), Leon Gardner, Sarah R. Atsatt.

[7]Baker edited Vol. 1 (1909) through no. 2, Vol. IV (1912). When Dr. W. A. Hilton succeeded as head of the department of biology and editor of the scientific journals he changed the name to Journal of Entomology and Zoology, beginning with Vol. V (1913).

[8]The Journal of Economic Botany edited by Baker continued through three volumes, I (1911), II (1912), III (1913). Its discontinuance was announced in nos. 3 and 4, Vol. III, Dec. 1914, by D. L. Crawford, then Professor of Botany at Pomona College.

[9]Published by the Department of Biology, Pomona College, Claremont, Calif. 218 p., 130 fig.

in 1912. The Pomona College marine station at Laguna Beach was organized almost entirely through the efforts of Professors Cook and Baker with financial assistance from a few local residents, and it is still ably conducted by Dr. Hilton.

In October 1911 the appointment of Prof. Cook as Horticultural Commissioner of California broke the magic ring of activities at Pomona. When he removed to Sacramento there was no one left to solicit the necessary funds to continue the work which was more than could be assumed by the College. Certain restrictions were also made to prevent outside solicitations for aid which appeared to handicap permanently the future development of the important work so gloriously started. After a year of disappointment Baker finally decided to accept the position of Professor of Agronomy at the University of the Philippines which was offered him by his good friend Dean E. B. Copeland, whom he succeeded in 1918. During his long stay in the Philippines he left only once and that was for a year's leave of absence in 1917–1918 to become assistant director of the Botanic Gardens at Singapore. Every ounce of vitality was poured into his work. His entomological collections received the greater part of his spare time. He maintained at his own expense a Cuban collector named Julian Hernandez whom he carefully trained and kept with him after he left Cuba in 1907. This man spent all of his time either collecting or caring for the insects, or in the domestic duties of a bachelor's household. Botany came in for a share also and fungi in particular were taken extensively throughout the Archipelago. Every cent of his salary that could be utilized went towards building up the collections. Concerning these he writes under date of April 27, 1925: "My outside work in entomology and mycology is the only thing that gives me any real satisfaction: that, at least, is done as it ought to be done and I can go on and develop it to the limit of personal possibilities without let or hindrance from anyone. I have pushed the number of foreign specialists engaged on our work up to one hundred ten, and keep them all busy! It thus has become one of the biggest projects of its kind in the world. And its ultimate permanent contribution to entomology will be very, very large. And this helps very materially to make the stay here worth while."

Failing health and gradual replacement of American teachers and investigators by Filipinos many times influenced him to desire to give up his position in the Philippines and seek a place of complete change and a haven of peace and quiet in America where he could find space to house and work on this large insect collection during the remaining years of his life. To this end an attempt was made to secure for him

a place at the California Academy of Sciences, but the difficulty of raising a proper endowment indefinitely delayed action until it is now too late. On August 30, 1925 he wrote: "The outside work I am carrying constantly looms larger and larger and it makes me want to stay here. But poor health will probably force me to cut loose ere long."

For several years he was considering an offer from a strong combination of all the entomological interests of the Hawaiian Islands to conduct extensive work in the western Pacific Islands,— "Over Wallace's Trail." His failure to negotiate terms in California and the opportunities offered by his own student, President Crawford, of the University of Hawaii, led him finally to accept the Hawaiian offer. Accordingly, he presented his resignation to the College of Agriculture, University of the Philippines, Los Banos, Laguna, P.I., to take effect in November 1927. In *Science*,[10] it is stated that "he expects to spend next year with one of the Pan-Pacific research committees on the South Sea Survey and thereafter will make headquarters at the University of Hawaii with President David Crawford. Arrangements have been made to house his large collection of natural history material at the Bishop Museum." On June 9, 1927 the Board of Regents of the University of the Philippines passed a resolution appointing him Professor of Tropical Agriculture and Dean Emeritus of the College of Agriculture of the University of the Philippines, and also Director Emeritus of the Experiment Station, effective December 1, 1927. His untimely death came before this much earned public recognition was realized.

His insect collection is a remarkable achievement amassed over a period of fourteen years of unremitted labor. From reports received from Baker in 1926 it contained approximately four hundred thousand specimens. On November 9, 1926 he wrote me concerning it: "The collection is undoubtedly the largest existing private collection covering extreme western Pacific. The pinned part of it is contained in one thousand five hundred cases, all crowded full. But as much more has been placed in the hands of one hundred ten (later one hundred fifteen) specialists[11] and considerable portions of the latter will be returned. I believe it is one of the most important collections *basic* to either Central and South Pacific work or to Southwest Asian studies since it

[10]Vol. LXVI, no. 1699, p. 77, July 22, 1927.

[11]Some of the specialists who were supplied with entomological material by Baker are: **Coleoptera**—Hans Gebien, R. Kleine, and A. Zimmermann, Germany; A. Boucomont, Ed. Fleutiaux, A. Grouvelle, and M. Pic, France; Jan Obenberger, Czecoslovak; H. Krekich-Strassoldo, Austria; Chr. Aurivillius, Sweden; H. E.

includes several thousand types and cotypes. Moreover, more material is constantly coming in and I have so arranged it that continued collections on a large scale will be made after I leave here. I also have a lot of fine Australian material constantly coming in. Moreover, I have taken the fullest advantage of exchange possibilities, making important exchanges with European museums and with individuals, in this way securing a vast number of species I lacked, many of these being cotypes."

According to S. A. Rohwer, information received by Dr. L. O. Howard from Baker indicates that the insect "collection is considerably larger than it was in November 1926, as Baker received from specialists quite a little material during the winter of 1926–27 and also continued to mount miscellaneous material which had been collected. The figures for the number of cases undoubtedly referred to the pinned part only. From information and letters, I gather that there is probably half as many specimens that are unmounted." All the mounting, labeling, packing and shipping to specialists was done by Baker himself at night, the entire work including the salary of the collector already referred to, cost of pins, boxes, labels, packing and postage, was supported by his modest salary, yet, as he states, "if one lives simply and rigorously as a Trappist monk, many things may be possible." According to his long-standing will, the main insect collection was bequeathed to the U. S. National Museum. The statement that small parts were also donated to the Universities of Berlin, London, Madrid, Paris, Moscow, and Vienna,[12] is probably erroneous. Crawford states that "he (Baker) was stricken so suddenly by this accute attack of dysentery that he had no time to make any changes in his will .... and according to cable information received from Manila his old will still stands whereby the U. S. National Museum is to receive his main insect collection and the University of the Philippines is to receive his main collection of plant material." Rohwer also states that "the will provides that the entire collection, manuscripts and notes, should come to the National

Andrewes and Guy A. K. Marshall, England; Edward A. Chapin, United States. **Orthoptera**—Achille Griffini, Italy; H. H. Karny, Dutch East Indies; A. N. Caudell, United States. **Homoptera**—Frederick Muir and D. L. Crawford, Hawaii; L. Melichar, Moravia; W. D. Funkhouser and T. D. A. Cockerell, United States. **Hemiptera**—W. L. McAtee and J. R. Malloch, United States. **Diptera**—P. Sack, Germany; W. S. Patton, Scotland; M. Bezzi, Italy; J. R. Malloch and G. F. Ferris, United States. **Hymenoptera**—E. A. Elliott, England; H. L. Viereck, Canada; T. D. A. Cockerell, United States. Baker worked chiefly in Homoptera on the Jassoidea, Fulgoridae, and Cercopidae, and in the Hymenoptera on the parasitic Braconidae, during his stay in the Philippines.

[12]Science, Vol. LXVI, no. 1701, p. 129. Aug. 5, 1927.

Museum. We have never been advised that there were any changes. The museum is planning to make arrangements to have the collection transferred to Washington as soon as practical after the will is probated."

Entomology and mycology were only side issues or hobbies, his real work was the development of agriculture in the Philippines. A perusal of files of the Philippine *Journal of Science*[13] and more particularly the Philippine *Agriculturist* and Philippine *Agricultural Review*, the last two of which he was associate editor, will give something of the results accomplished. Concerning this broader work the following editorial of the *Tribune*[14] is pertinent: "The Baker Leadership! The University of the Philippines can ill afford to lose the services of Dean Charles F. Baker of the College of Agriculture. He has made of his college an institution of the highest standing in this country and one to which recognition abroad has been deservedly given. The Los Banos unit of the University (is) what it is because Dean Baker has put in its organization and management much of his own forceful personality and transferred to the faculty his own enthusiasm for its mission.

"The work of bringing advance methods of agricultural practices to the people on the farms has only been started. It is the work not for a decade but for a generation. In this task Dean Baker has been easily a recognized leader. It is not too much to say of him that, were he to leave the college permanently, the Baker leadership will yet be felt through years to come. It is a measure of his success that what is often good in scientific agriculture may be traced to a Baker tradition."

Baker was a member of the American Association for the Advancement of Science, American Association of Economic Entomologists, Entomological Society of America, Washington Entomological Society, Southern California Academy of Sciences, and the Havana Academy.

Although he died comparatively young, he did the life work of ten men.

E. O. Essig, *University of California, Berkeley, California, August 15, 1927.*

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[13]In this journal were published the results of much of the entomological work done by Baker and his large corps of specialists to whom he forwarded his material.

[14]Independent Filipino Daily, Carlos P. Romulo, editor, Manila, P. I., p. 4, Nov. 6, 1926.

Reviews

All entomology is economic. We are dealing not with isolated, pestiferous insects but with such species in a biological complex which may never be fully understood. We must know the fauna and for that matter the flora also. The two works reviewed below are comprehensive attempts to crystallize information about certain groups.

General Catalogue of the Hemiptera, Fascicle 1, Membracidae by W. D. FUNKHOUSER. Published by Smith College, Northampton, Mass., pp. 1–581, 1927.

This is the first part of a much needed world catalogue of this important group. It lists the species, indicates the synonymy, includes the more important refeiences with indications of their character, and gives the recorded distribution. It is a ready index to the genera, species and literature of this none too well known order and therefore valuable to every working entomologist giving attention to the Hemiptera. No attempt has been made to indicate relationships beyond the subfamilies except in the Smiliinae. The species are arranged alphabetically under each genus. Each species is recorded under every genus in which it has been placed with the correct reference. The bibliographies for genera and species are chronological. The general bibliograpy is arranged by authors, the various citations chronological. The initial fascicle promises well for the series to follow. The author is to be congratulated upon having completed a valuable contribution to science in such an admirable manner.

E. P. FELT

Guide to the Insects of Connecticut, Part V, The Odonata or Dragonflies of Connecticut by PHILIP GARMAN, Conn. Geol. and Nat. Hist. Surv., Bul. 39, pp. 1–331, 1927.

This is a worthy addition to the series on insects started in 1911 and comprising, in addition to the Introduction by Dr. Britton, volumes on the Euplexoptera and Orthoptera, Hymenoptera and Hemiptera. May the series be completed in the not distant future.

There is much to commend in this latest addition. The introduction is a model of comprehensiveness and conciseness. The systematic portion contains keys for adults (both sexes) and nymphs of genera and species, as well as descriptions of the sexes and nymphs and distributional records. The numerous excellent illustrations add greatly to the value of the text. There is a well selected bibliography, a glossary and an excellent index. The author records 48 genera and 112 species, of these professional predators from Connecticut. There should be more works like this in other states and in many groups if we are to know insects as they should be known

E. P. FELT

Current Notes

Professor T. D. A. Cockerell is traveling in Russia and Siberia and reached Leningrad on July 10.

Mr. James A. Hyslop has been elected president of the Entomological Society of Washington for 1927.

Dr. S. Marcovitch is now back at Knoxville, Tennessee, after completing his graduate studies at the University of Minnesota.

Mr. H. K. Riley, a graduate of Iowa State College, has accepted a position as assistant entomologist at Purdue University.

Mr. W. W. Stanley, graduate of Montana Agricultural College, has been appointed assistant entomologist at the Tennessee Experiment Station.

Dr. H. H. Stage, Entomologist of the Cotton Belt Railway, Pine Bluff, Arkansas, was a visitor at Entomological Branch Headquarters, Ottawa, on July 29.

Mr. R. A. Cushman of the U. S. National Museum spent June 20 to 24 in Philadelphia, studying types of Ichneumonidae at the Academy of Natural Sciences.

Mr. M. D. Farrar, Instructor of Zoology and Entomology, South Dakota Agricultural College, is taking graduate work in entomology at Iowa State College.

Recent appointments in the Entomological Branch, Canadian Department of Agriculture, are announced as follows: Temporary Insect Pest Investigators, W. C. Bourne, Fredericton Laboratory, F. W. Barnes, Lethbridge Laboratory.

Mr. F. E. Whitehead, Associate Professor of Entomology, University of Idaho, has been granted a leave of absence to take graduate work in entomology at Iowa State College.

Dr. E. A. Back, of the Bureau of Entomology, attended the convention of the National Furniture Warehousemen's Association held in the Grand Hotel, Mackinac Island, Michigan, July 8 to 13.

Dr. R. B. Friend and Mr. J. Peter Johnson of the Connecticut Agricultural Experiment Station visited the Asiatic beetle field station at Westbury, Long Island, N. Y., on July 27.

Mr. R. S. Filmer, a recent graduate of the Connecticut Agricultural College, has been appointed Junior Entomologist, Bureau of Entomology, and will assist in the studies on stomach poisons.

W. Gamkrelidze, a graduate of the University of Paris, has been appointed Specialist in Parasites in the Bureau of Entomology, and assigned to the European parasite Laboratory, Hyères (Var) France.

Mr. G. Stuart Walley, of the Department of Agriculture of Canada, is taking graduate work in entomology at Iowa State College. Mr. Walley is doing some special work in insect morphology.

The degree of Doctor of Philosophy in Entomology was conferred upon Mr. C. R. Jones, Associate Professor of Entomology, Colorado Agricultural College, Fort Collins, Colorado, at the June Commencement of Iowa State College.

Prof. O. W. Rosewall, head of the entomology department of Louisiana State University, has been granted a year's leave of absence in order to take graduate work in entomology at Iowa State College.

Messrs. M. H. Brunson of the Pee Dee Boll Weevil Laboratory, Florence, S. C., and Roy Melvin of the Mississippi A. & M. College, are taking graduate work in entomology at Iowa State College.

According to *Science*, Mr. W. L. McAtee has returned from Europe where he spent three months on official business connected with the Bureau of Biological Survey and the Bureau of Entomology.

The degree of Doctor of Science has been conferred by De Pauw University on Dr. William Albert Riley, head of the department of animal biology of the University of Minnesota.

The offices and laboratories of the department of entomology at the University of Illinois have recently been moved into new quarters in the building formerly occupied by the College of Law.

A new animal science building is to be erected by California University and Station at Davis, to cost $300,000. This will house the division of entomology and parasitology and several other departments.

Dr. Garry DeN. Hough, a physician, and former student of the Muscidae, died at Vineyard Haven, Massachusetts, on May 31, 1927. Dr. Hough published several taxonomic papers in *Entomological News* thirty years ago.

Mr. R. A. Roberts, graduate of Texas A. & M. College, is taking graduate work in entomology at Iowa State College. Mr. Roberts has been assisting Dr. F. C. Bishopp of Dallas, Texas, during the past summer.

Mr. Harold H. Shepard, who has recently received the degree of Master of Science from the Maryland University, has been appointed Assistant Entomologist in the Bureau of Entomology. He will assist in the work on contact insecticides.

Visitors at the laboratories of the Department of Entomology at the Kansas State Agricultural College during July included Professor R. W. Harned of Mississippi, Professor W. C. O'Kane of New Hampshire, and Mr. J. R. Horton of the Bureau of Entomology; during August, R. L. Webster, Pullman Wash.; J. S. Houser, H. L. Gui, and G. A. Filinger of Wooster, Ohio; F. E. Whitehead, Moscow, Idaho, and D. B. Whelan, Lincoln, Nebr.

Dr. F. C. Craighead of the Bureau of Entomology left Missoula, Montana, on July 16 for Coeur d'Alene, Idaho. From the latter point he proceeded to the Colorado National Forest, where studies of the Black Hills beetle are being conducted.

Professor William E. Hoffmann, head of the biology department of Lingnan University, Canton, China, has been sent by that institution to the Philippine Islands where he is to spend two months investigating insect problems common to South China and the Philippines.

Messrs. L. H. Worthley, Toledo, Ohio, Dr. S. B. Fracker, Washington, D. C., R. A. Sheals, Providence, R. I., A. F. Burgess, Melrose Highlands, Mass., Loren B. Smith, J. L. King, R. W. Sherman, Riverton, N. J., and R. A. Vickery, Stratford, Conn., are among the recent callers at the Department of Entomology, Agricultural Experiment Station, New Haven, Conn.

Messrs. Ralph Hopping, E. R. Buckell, Arthur Kelsall, W. Downes, E. P. Venables, and A. A. Dennys of the Entomological Branch, attended the meetings of the Western Horticulturists, Entomologists and Plant Pathologists held at Pullman, Washington, and Moscow, Idaho, from June 24 to July 3.

The Egyptian Government has advertised for economic entomologists to fill three positions: (1) Chief of division, salary $10,000; (2) Assistant Chief, salary $5,000; (3) salary $3,000. It is understood that American men of scientific training and ability will be welcomed in Egypt.

Professor A. E. Stene, State Entomologist of Rhode Island, and Harry Horovitz, Superintendent of Field Work in the Rhode Island State Department of Agriculture, recently conferred with members of the Japanese Beetle Laboratory force, Riverton, New Jersey, relative to present research methods and results.

Mr. Arthur Kelsall of the Annapolis Royal, N. S. laboratory, returned the last of July, after having completed an extensive trip through the southern part of the Dominion as far west as the Pacific Coast, gathering data at the various entomological laboratories for use in future insecticide investigations.

Mr. D. J. Caffrey returned to headquarters at Arlington, Mass., on July 2, after spending the greater part of April, May, and June in the Middle West, in connection with the corn borer clean-up campaign and the various corn borer research projects under way in that section.

Dr. S. P. Minkiewicz, Entomologist of the Institute for Agricultural Research, Pulawy, Poland, spent the first week of September at the Kansas State Agricultural College, conferring with the members of the staff of the Department of Entomology on projects, organization and methods of conducting research work.

The directors of the Texas Pecan Growers Association at their annual meeting held July 12 at Gonzales, Texas, awarded the distinguished service medal to Dr. S. W. Bilsing for his research work on the life history and control of the pecan nut case bearer (*Acrobasis caryae*).

On June 28, Mr. J. L. King started the parasite introduction for the control of *Anomala orientalis* at Westbury, Long Island. A number of female *Tiphia vernalis* were introduced at this time. Mr. H. C. Hallock, formerly of the Japanese Beetle Laboratory, will have charge of the rearing work on Long Island.

The following recent transfers in the Bureau of Entomology have been announced: C. H. Griffith, Twin Falls, Idaho, to Corvallis, Oregon; J. U. Gilmore and S. F. Grubbs, Clarksville, Tenn., to Appomattox, Va.; S. E. Crumb and K. B. McKinney, Clarksville, Tenn., to Lexington, Ky.; F. A. Fenton to pink bollworm, El Paso, Texas.

The insecticide unit of the Division of Deciduous Fruit Insect Investigations, Bureau of Entomology, at Washington, D. C., has recently been enlarged to include investigations on stomach poisons, in addition to the work on contact insecticides already under way. These investigations have been placed under the direction of Dr. C. H. Richardson.

Recent visitors at the Monroe, Michigan corn borer laboratory of the Bureau of Entomology included Professor H. F. Wilson of the University of Wisconsin; Professor J. J. Davis and Dr. Kraybill of Purdue University; Professor C. W. Woodworth of the University of California, and Dr. Herbert Osborn and Herbert Osborn, Jr., of the Ohio State University.

Mr. V. I. Safro has been appointed Director, Japanese Beetle Suppression, by the New Jersey State Department of Agriculture, with office at Trenton, N. J., and field headquarters at the Japanese Beetle Laboratory, Moorestown, N. J. Control work will be conducted in close cooperation with the Japanese Beetle organization of the U. S. Bureau of Entomology.

Dr. F. L. Campbell, formerly Assistant Professor of Biology, New York University, has been appointed Associate Entomologist in the Division of Deciduous Fruit Insect Investigations, Bureau of Entomology. He has been placed in charge of investigations on arsenical substitutes and on the toxicology of stomach poisons at Washington, D. C., under the general supervision of Dr. C. H. Richardson

Méssrs. Walter Carter, of Twin Falls, Idaho, and R. E. Campbell, of Alhambra, Calif., attended the meetings of the Pacific Slope Branch of the American Association of Economic Entomologists held at Reno, Nevada, June 22 to 25. From Reno Mr. Carter went to Berkeley and other points in California to confer with State officials regarding investigations on the sugar-beet leafhopper.

On July 5, a conference regarding insects was held at Sacramento, Calif. Among those present were Lee Strong, of the California State Department of Agriculture, D. K. Gradv of San Francisco, Secretary of the California Dried Fruit Association, Perez Simmons and W. D. Reed, of the Bureau's laboratory at Fresno, Calif., and Professor W. C. O'Kane of the Crop Protection Institute.

Mr. A. B. Baird, of the Chatham, Ontario laboratory, reports that larch sawfly parasites of the species *Mesoleius tenthredinus* have been emerging since early June from larch sawfly cocoons shipped to the laboratory from Treesbank, Manitoba, by Mr. Norman Criddle. Numbers of these parasites have already been liberated in the Provincial Forest Nursery at St. Williams, Ontario, and at Fredericton, N. B.

Collections of larvae of the Mexican bean beetle were made by Mr. C. S. Thompson in the vicinity of Chatham, Ontario, in July, this constituting the official record of this insect in Canada. Mr. Thompson has since made several collections of the beetle in the Loamington district, and Mr. W. A. Fowler reports its occurrence in the Toronto district, at Lambton Mills.

Dr. W. R. Thompson, Director of the European Parasite Laboratory, and Professor R. N. Chapman, who passed the winter there working on biotic potential under a Guggenheim fellowship, delivered papers at the International Zoological Congress at Budapest. Dr. Thompson and Dr. H. L. Parker, also of the Parasite Laboratory, have been awarded the Prix Passet by the French Entomological Society for their works on Tachinid larvae and Chalcid larvae respectively.

Messrs. J. C. Hamlin and W. D. Reed, entomologists at the Fresno, Calif. field station of the Bureau of Entomology, recently fumigated $500,000 worth of dried fruits with sulphur dioxide, carbon disulphide, and hydrocyanic acid gas. These were practical fumigations on a large scale and gave valuable results. The Dried Fruit Association of California has informed the Bureau that it will make another $1,000 contribution toward the work on the insects of dried fruit in California.

The Mexican fruit worm having been found at Brownsville, Texas, Dr. A. C. Baker made a trip there during the last week in June for the purpose of investigating the insect in that general region. He also investigated the insect in several of the states in Mexico. Dr. Baker was joined in this work by Mr. James Zetek, in charge of the Bureau's laboratory at Ancon, Canal Zone.

A Japanese beetle quarantine office was recently established at 682 Main Street, Stamford, Conn., to supervise the quarantine activities in Connecticut. This office is in charge of Mr. J. P. Johnson, who has been engaged in control work on *Anomala*

orientalis for the State of Connecticut. Temporary quarantine offices have also been opened at Hamburg and Allentown, Pa., in the territory added to the regulated area with the last revision of the quarantine.

A portion of the foreign parasites of the corn borer which have been shipped from Arlington to the Middle West for liberation in the field, have included adults of *Angitia punctoria* Roman, which were reared from corn borer material collected in New England. This foreign parasite of the corn borer, originally introduced into New England, has been recovered in increasing numbers each year in that area, and is now being used for recolonization.

The Federal Government and the States of New Jersey, Pennsylvania, Delaware, New York, and Connecticut, now employ coöperatively 517 men on Japanese beetle quarantine work. Of these, 151 are located in New Jersey, 180 in Pennsylvania, 40 in Delaware, 79 in New York, and 49 in Connecticut, and 18 men are engaged in scouting operations outside of the present regulated area. The majority of these men are employed temporarily for the summer months, beginning their work July 5, and continuing until the middle of September.

At Bound Brook, New Jersey, on July 20, Messrs. A. F. Burgess and H. L. Blaisdell had a conference with Mr. H. L. McIntyre, Supervisor Forest Pest Control, Conservation Department, Albany, N. Y., where the gipsy moth work was discussed. Accompanied by Mr. McIntyre, they were then shown the State gipsy moth work on Long Island, where several infestations were visited. The 22d of July was spent in conference with Federal field men at the storehouse at Pittsfield, Mass. The following day they attended the summer meeting of the Massachusetts Tree Wardens and Foresters Association at Worcester, Mass.

Among the recent visitors at the Gipsy Moth Laboratory, Melrose Highlands, Mass. have been Messrs. J. L. King and H. W. Allen, of the Japanese Beetle investigations; F. I. Spruijt of the Horticultural Commission of California; Dr. S. Minkiewicz, Entomologist of the Institute of Agricultural Research at Pulawy, Poland; F. G. Holdaway and S. Garthside, entomologists from Melbourne, Australia; Dr. R. W. Glaser of the Rockefeller Institute for Medical Research at Princeton, N. J.; R. C. Smith, Professor of Entomology at Manhattan, Kansas; Dr. N. Yagi, Entomologist at Kyoto Imperial University of Japan; and Allen Swain of Boston and Charles Ricker of Poland Springs, Maine.

Living bees performing their daily activities in a glass observation hive constitute an entirely new and fascinating exhibit in the food section of the United States National Museum. Two firms manufacturing beekeeping supplies furnished the hive and necessary equipment. This includes a double glass case, insulated against heat and cold, and a 12-foot glass tunnel connected with an opening on the outside wall of the Museum, through which the bees pass to go out into the surrounding parks in search of nectar and pollen. A colony of about 40,000 bees was supplied by the Bureau of Entomology.

Dr. T. E. Snyder, Bureau of Entomology, spent June 8 and 9 at Henderson, Kentucky, consulting with house owners on methods of eradicating subterranean termites which were damaging the woodwork of buildings. In several instances at Henderson these termites had penetrated and damaged the buildings, owing to the fact that inferior grades of mortar had been used in the brick foundations. On June 13, Mr. C. W. Knowles, Director of Agriculture, Accra, Gold Coast, British West Africa, consulted with Dr. Snyder in regard to methods of termite control, in whose district termites are one of the major pests.

Recent visitors at the Hyères Laboratory, France were: Dr. L. O. Howard, Washington, Professor E. N. Transeau of the Ohio State University, Columbus, Professor Metalnikov, Pasteur Institute, Paris, and Deans C. F. Curtiss of Iowa and G. I. Christie of Indiana. Professor Transeau and Dr. H. L. Parker recently made a tour of southwestern France, studying plant associations in connection with the degree of infestation of corn by *Pyrausta nubilalis.* This summer Dr. Parker collected at Bergamo, in Lombardy, 30,200 *Pyrausta nubilalis* chrysalids parasitized by *Phaeogenes planifrons* and 7500 cocoons of *Angitia punctoria.* These were shipped from Genoa, Italy, to this country, on August 9.

The total number of *Pyrausta* parasites shipped from Hyères, to the United States during the last fiscal year were: *Eulimneria crassifemur* 47,340; *Dioctes (Angitia) punctoria* 11,209; *Masicera senilis* 1,652; *Microgaster tibialis* 166,722; *Phaeogenes planiforns* 17,017. Besides these, 1,661,590 larvae of *P. nubilalis* were sent to Arlington, and from them were reared 42,704 *Zenillia roseanae;* 11,447 *Macrocentrus abdominalis.*87 *Angitia punctoria,* 33,175 *Apanteles* sp.; and 6,684 *Masicera senilis,* making 338,037 parasites altogether. To collect these parasites 150 laborers were employed in northern Italy from July 25 to August 10, 1926, and 146 during the months of November and December, 1926, and January and February, 1927.

The Japanese Beetle Laboratory at Riverton, New Jersey, received a large shipment of *Tiphia vernalis* from Korea on June 12. The parasites were shipped as adults in specially prepared tins bearing supplies of water and food. The success of this shipment was very remarkable, as 80 per cent of it came through in good condition after being twenty days en route. The wasps were used in part for immediate colonization and in part for propagation, the latter resulting in the production of about 15,000 eggs. The parasitized beetle larvae bearing these eggs were transferred from the laboratory to the field, where under normal conditions they are able to develop into adult wasps.

Centeter cinerea, a tachinid parasite of the adult Japanese beetle, is proving to be more abundant this year than last. Since its introduction in 1923, this species has constantly increased, and in 1926 records indicated that an area of approximately 62 square miles was covered. It is hoped that at the close of the present season this area will have been materially increased. In the present season the colonizations of *Prosena siberita, Ochromeigenia ormioides, Tiphia vernalis,* and the so-called "Japanese red-legged" Tiphia have been much larger and more satisfactory than in former years. This achievement has been due in large measure to the excellence of the shipments from Japan, and to the gradual improvement in the technique of handling at the receiving station.

Dr. J. M. Swaine, Entomological Branch, Ottawa, returned to Ottawa recently from Cape Breton Island where he had been supervising e periments in airplane dusting in the control of the spruce budworm. These experiments, which were made possible by the coöperation of the Air Board, are still in progress in Guysboro County, and are producing valuable data for use in future work. Dr. Swaine sailed for Europe on August 6 on the S. S. *Regina,* to attend the International Congress on Zoölogy at Budapest, Hungary, September 6 to 11, and the Imperial Agricultural Research Conference which will meet in London early in October. Dr. Swaine also plans to visit a number of European forests, forestry schools and scientific laboratories, particularly in France, Italy, Germany and Sweden.

Mr. R. K. Fletcher, Associate Professor in the Department of Entomology of the A. & M. College of Texas, has resigned to accept the position of entomologist at the Texas Agricultural Experiment Station. The following appointments as entomologists have recently been made: W. L. Owen, Jr., J. C. Gaines, Jr., Franklin Sherman III, F. F. Bibby, and L. B. Coffin; and the following as assistant entomologists: T. R. Adkins, C. J. Todd, V. O. McCoy, and J. N. Roney, to work in connection with the cotton flea hopper, boll weevil, and cotton bollworm investigations. An emergency appropriation of $15,000 was granted by act of the Legislature in May, 1927, and an appropriation of $5,500 was also made for truck crop insect investigations to be carried on mainly in Galveston County.

Mr. C. H. Popenoe of the Bureau of Entomology left Washington on June 20 on a trip to points in southwestern Michigan, to confer with various workers regarding the transmission of berry mosaics by insects, and returned on June 28. On the way out, Mr. Popenoe stopped at East Lansing, Michigan, and conferred with Professor C. W. Bennett of the Agricultural College as to technical methods in the demonstration of mosaic symptoms in plants and in pathological treatment. In southwestern Michigan a large number of fields were visited and studied. These contained the streak or blue-stem disease, leaf-curl, and the yellow, mild, and red raspberry mosaics. Other berries were also studied in which chlorotic symptoms as yet unknown to belong to the mosaic group were manifest.

Ground has been broken for a new building for the Tropical Insect work of the Bureau of Entomology in New Orelans. It will contain office and laboratory quarters, a cold room controlled by a refrigeration plant, greenhouse and insectary units, and a shop for the construction of special apparatus. Storage space is provided for spray machinery and other field equipment, and two acres adjacent to the buildings are allotted for special experimental plots. The laboratory will contain a battery of incubators and other special apparatus for study under controlled conditions, and full equipment will be provided for the statistical analysis of data gathered in field experimentation where conditions are not under control. Thus factors developed by an analysis of the varying conditions in the field can be studied in parallel series under control in the laboratory.

Mr. Arthur Gibson, Dominion Entomologist, visited the inspection station at Niagara Falls, Ontario, on June 23, after which Mr. Ross of the Vineland laboratory accompanied him on a visit to the experiment station at Geneva, N. Y., to confer with Professor Parrott, in charge of the entomological research work at the station. Mr. Gibson later spent a short time at Vineland, Ontario, and also visited several orchards in the district infested with the Oriental peach moth. During the latter part of July and early August, Mr. Gibson visited districts in the Niagara peninsula, Ontario, where orchard insect investigations are being conducted; namely, St. Davids, Vineland, Burlington, Beamsville, and Grimsby. On August 4 Mr. Gibson addressed the Orillia Kiwanis Club on mosquito control, and later visited the Ontario Agricultural College, where he conferred with Professors Caesar and Baker of the Department of Entomology.

Dr. E. A. Chapin went to Springfield, Mass. on June 8, to arrange to bring to Washington the insect collection of Dr. George Dimmock. Dr. Dimmock has presented the National Museum with his collection of adults, larvae, slides and notes, consisting of 15 large double boxes of pinned material (amounting to about 35 Schmitt boxes); about 3,500 small glass tubes of material preserved dry, consisting

of the shed skins of larvae of all stages, pupae, some adults, and all of the parasites which emerged in the course of Dr. Dimmock's rearings; a small amount of alcoholic material; about 2,650 numbered notes, which are in some cases mere skeleton records of capture on a certain food plant, but in many cases are extremely detailed, covering three or four pages. Dr. Dimmock has spent about fifty years studying the life histories and habi‑s of insects of the New England States, and has gathered together a great amount of valuable material. This collection will be deposited in the National Museum, where it will be available to all of the Bureau specialists. It will be distributed and incorporated under the direction of Dr. Chapin.

Recent appointments in the Bureau of Entomology have been announced as follows: R. M. Jones, J. W. Frankenfeld, corn borer laboratory, Sandusky, Ohio; A. E. Pillsbury, L. W. Ziegler, corn borer laboratory, Silver Creek, N. Y.; Dr. F. L. Campbell, R. S. Filmer, Washington, D. C.; Prof. Lloyd M. Bertholf, Mary L. Crossman (temporary), Washington, D. C.; K. B. Rogers, H. W. Coward, Curtis H. McDonnell, Japanese Beetle Laboratory, Riverton, N. J.; Temporary (Japanese Beetle) Prof. O. G. Anderson, Howard Stackhouse, Rankin Watson, C. E. Jennings, H. H. DeCou, M. M. Ott, G. A. Fails, P. R. Dennis, I. L. Hunt, Jr., R. L. Tripp, H. S. Margerum, Nathaniel Tischler, Daniel Ludwig, F. L. Else, R. N. Johnson, J. S. Holder, W. H. Minor, Jr., W. B. Redmond, H. F. Strohecker, Marshall Kerry; K. E. Gibson, Walla Walla, Wash.; E. C. Herber, I. R. Taylor, Philadelphia, Pa.; Dr. D. M. De Long, O. E. Hahm, H. L. Weatherby, Columbus, Ohio, Joe Millam, S. F. Grubbs, S. C. Lyon, W. T. Darrow, Clarksville, Tenn.; J. E. Durham, Estancia N. M.; L. P. Clarke, Richfield, Utah.; V. E. Romney, Twin Falls, Idaho; T. P. Dawkins, Gulfport, Miss.; M. E. Ryberg, Yonkers, N. Y.: W. E. Dove, H. M. Brundrett, Dallas, Texas; R. T. Alexander, R. L. Callihan, G. L. Hales, L. Johnson, L. J. Padget, J. C. Pearson, J. K. V. Stewart, Tallulah, La.; W. A. Brunson, G. M. Stone, Florence, S. C.; G. A. Orum, H. I. West, Foley, Ala.; W. C. Northrup, C. Harry Linsley, Laramie, Wyo.; Dr. C. H. Batchelder, E. S. Mack, D. D. Questel, H. G. Guy, R. A. Biron, James Wallace, J. Sawyer, R. G. Lassiter, Corn borer laboratory, Arlington, Mass.

The tenth annual meeting of the Northwest Association of Horticulturists, Entomologists and Plant Pathologists was held at the University of Idaho, Moscow and the State College of Washington, Pullman, June 27, 28 and 29, 1927, with an attendance of more than one hundred entomologists, plant pathologists and horticultural specialists, inspectors, orchardists and commercial insecticide dealers. The first day's session held at the University of Idaho was addressed by Dr. A. H. Upham, President, on Land Grant Colleges and Research. The remainder of the morning was devoted to visiting the University departments and the Experiment Station farm. The afternoon was spent in a discussion of the Spray Residue situation in the North west, led by Mr. H. Hartman, Pomologist, O.A.C.

President E. O. Holland, W. S. C. opened Tuesday's session with an address on Science and its Service to Civilization. On Wednesday the college departments and the experiment station farm of the State College of Washington were visited followed by an automobile excursion to the Lewiston-Clarkston irrigation project over the Scenic Highway.

Among the entomologists present were registered Ralph Hopping; M. C. Lane; L. C. Rockwood; T. R. Chamberlain; F. E. Whitehead; E. P. Venables; A. A. Dennep; A. Kelsall; E. R. Buckell; Anthony Spuler; F. H. Shirck; K. E. Gibson; M. W.

Stone; Don C. Mote; Chas. C. Prouty; M. A. Yothers; George Hopping; Leroy Childs; E. J. Newcomer; R. L. Webster; W. Downs. The Officers elected for 1928 are E. J. Newcomer President, H. E. Morris Vice-President, and A. F. Barss Secretary. The eleventh annual meeting will be held in Vancouver, B. C.

Notes on Horticultural Inspection

Mr. William R. Shinn was recently transferred from his station in Boston to Seattle, Wash., to assist in the inspection work of the Federal Horticultural Board.

Mr. O. D. Deputy, chief inspector Mexican border service, recently made a visit to the various ports of the Federal Horticultural Board on the Mexican border.

Mr. Paul A. Hoidale has been placed in charge of Mexican fruit worm control carried on by the Bureau of Entomology in cooperation with the Federal Horticultural Board in the lower Rio Grande valley of Texas.

Mr. Charles E. Prince, Jr., a plant quarantine inspector of the Federal Horticultural Board, who has been stationed for some time in New York City, has been transferred to Norfolk, Va., to take charge of the Board's work at that port.

The State Department of Agriculture of Texas has announced two new intrastate quarantines, one restricting the movement of sweet potato plants and the other cotton and cotton products from the pink boll worm infested countries.

Mr. Herschell Fox was recently transferred from Nogales, Ariz. to Porto Rico to assist in the inspection and certification of fruit offered for shipment to the mainland, and in the enforcement of foreign plant quarantines.

It has been found that the mango weevil (*Sternochetus mangiferae* Fab.) is present in many shipments of seed imported from countries where the mango is grown. Owing to the difficulty experienced in detecting this insect in infested mango seeds they will hereafter be refused entry.

The Japanese Beetle Quarantine restrictions have been modified by a revision of Amendment No. 2 to rules and regulations supplemental to Quarantine No. 48. The revision involves Regulation 5, "Control of Movement of Farm Products and Cut Flowers," by requiring that such products when grown within the infested area be certified before movement by boat from New York City.

Dr. S. B. Fracker, in charge of domestic plant quarantines, Federal Horticultural Board, spent several days in September investigating methods of inspecting and disinfecting narcissus bulbs on Long Island; in visiting recent Japanese beetle infestations in Connecticut and in going over the Anomala beetle infestation in New Haven with Dr. W. E. Britton.

An interesting article appeared in the Monthly Bulletin of the Department of Agriculture of California, Vol. 16, No. 7, July, 1927, entitled "The National Plant Board" by Lee A. Strong, chairman of that Board. Mr. Strong in this article discusses the accomplishments of the Board, and its possible effect on the trend of quarantine work in the United States.

Mr. F. H. Benjamin was appointed August 1 as Assistant Entomologist in the Mexican border service of the Federal Horticultural Board. His duties are to make

preliminary identifications of insect material suspected of being the Mexican fruit worm, which may be collected in the lower Rio Grande valley, or in fruit at Brownsville coming across the border from Mexico.

Several additions have been made recently to the inspection force at Brownsville to assist in inspection work at that point. The men who have reported there for work are Mr. Robert B. Lattimore, transferred from the pink boll worm eradication work; Mr. F. E. Swan, transferred from Laredo and Mr. Wallace S. Jones, appointed as Junior Plant Quarantine Inspector.

In the mimeographed circular "With the Cornborer" issued September 10 by the Department of Agriculture, it was shown that the European corn borer, in addition to the area known to be infested in 1926, had spread to additional townships in a number of states as follows: 22 counties in Ohio; 8 counties in Indiana; 5 counties in Michigan; 12 counties in Pennsylvania, and 1 county in New York.

A conference was held on September 21, 22 and 23 to discuss the European corn borer situation, and to take stock of the work that has been done during the past summer. Those taking part in the conference met at Toledo, Ohio. The first day was spent in visiting infested areas in Ohio and Michigan; the second on a tour of the infested territory in Ontario, and the third in a general conference meeting at Detroit.

Quarantine No. 61, on account of the Thurberia weevil, has been revised effective August 1, 1927 because of the discovery of infestations in two additional counties of Arizona. In addition to extending the regulated area by adding all of Cochise and part of Graham Counties an important change has been made in the restrictions on the interstate movement of the products enumerated in the quarantine by requiring the compression of cotton lint, as well as its disinfection.

Inspectors of the Federal Horticultural Board have been at work during the summer inspecting shipments of foreign plant material received in this country under special permit. The inspection has been made partly by men from the Washington office and partly by inspectors located at different points in the states. Those who have been engaged in this work are L. M. Scott, H. L. Sanford, W. S. Fields, A. J. Bruman, J. M. R. Adams, W. G. Bemis, R. W. Woodbury, C. A. Davis, H. W. Hecker, A. C. Hill, A. G. Webb, E. I. Smith, M. J. Forsell, W. T. Owrey, W. B. Wood, and Peter Bisset.

Permits to import walnuts and filberts are no longer required, as inspection during the last season showed these nuts to be free from injurious insects. The importation of chestnuts, cobnuts and acorns, however, during the shipping season of 1927–1928 will be authorized under permit only and only such shipments as are shown by inspection at the port of entry to be free from infestation by the "European Codling Moth," "Chestnut Weevils" and other dangerous insects will be permitted to enter.

Quarantine No. 52 on account of the pink boll worm has been revised because of the discovery of the establishment of this pest in southeastern Arizona in the counties of Cochise, Graham and Greenlee and also the determination of its spread in New Mexico into the counties of Grant, Hidalgo and Luna. The only important change in the restrictions on the interstate movement of the products enumerated is in the quarantine requirement of compression as well as disinfection of cotton lint for interstate movement.

A reinvestigation of the fruit fly situation in Spain with respect to the existing embargo on the entry of Spanish grapes is to be undertaken by the United States Department of Agriculture in September, October, and November of this year—particularly with respect to the Province of Almeria. This reinvestigation has been authorized in response to requests received through the Spanish Embassy in Washington. Max Kisliuk, Jr., has been selected to represent the Department of Agriculture in the proposed survey in Spain. The early part of the work will be to determine the present status of the fruit fly with respect to fruit crops ripening earlier than the grape. At the end of September and in October the actual situation of the grape crop, which is the last to be attacked, will be determined. It is expected that this survey will be made in cooperation with specialists and officials designated by the Spanish Government.

Quarantine No. 64, promulgated to prevent the spread of the Mexican Fruit Worm, (*Anastrepha ludens*, Loew), was recently issued, effective August 15, 1927. The territory placed under quarantine consists of Cameron, Hildalgo and Willacy counties in the lower Rio Grande Valley in Texas. The products affected include grapefruit, oranges, and all other citrus fruits, except lemons and sour limes; also peaches, apples, pears, plums, mangoes, sapotas, quinces, apricots, mameys, ciruelas and guavas. None of these may be shipped from the regulated areas, except grapefruit and certain other approved fruits which may be shipped under permit issued by the Department of Agriculture. An attempt to eradicate the pest by starvation is now in progress and all quarantine and control measures are based on this idea.

The European corn borer regulations which required the inspection and certification of shelled corn before permitting it to move from an infested area have been revised, effective September 1, 1927. The first season's administration of the regulations has resulted in the general adoption of adequate cleaning methods throughout the infested areas. This fact makes it possible to administer the regulations by substituting for the separate examination of each car or sack of corn, less expensive but equally efficient measures, namely, (a) inspection of dealers premises at frequent intervals; (b) their agreements to comply with the regulations, and (c) regular inspection of corn in transit to see that dealers are complying with such agreements.

The following paragraph from the Insect Pest Survey Bulletin, Vol. VII, No. 7, indicates the spread of the Japanese Beetle beyond the present quarantine lines so far as it is known.

> The Japanese beetle has been found this summer at the following points outside the regulated area: Wilkesbarre, Lehighton and Gettysburg, Pa.; Baltimore, Cambridge and Chesapeake City, Md.; Clayton, Del.; Washington, D. C.; Lindenhurst (L. I.) and Nyack, N. Y.; and Bridgeport, Conn. A few individual beetles have been found in several freight yards outside the regulated area, the indications being that they were carried there in or on cars of non-agricultural freight from the heavily infested districts. While it is not practicable to change the quarantine line during the scouting season, provision is made to restrict the movement of any nursery stock or farm products from the outside points when the beetle has been found recently established. Most of the finds outside the regulated area have thus far occurred in built up residential areas. Cold, rainy weather during August retarded the activity of the beetles, and may result in greatly reducing the natural spread of the insect during 1927.

Apicultural Notes

The summer meeting of the Michigan Beekeepers' Association was held at Petoskey, August 25 and 26.

The eleventh annual meeting of the North Carolina State Beekeepers' Association was scheduled to be held at Asheville on September 8 and 9.

The New Hampshire Beekeepers' Association held its annual meeting at the University at Durham on August 18, in connection with Farmers' and Homemakers' Week.

Mr. J. I. Hambleton represented the Bee Culture Laboratory of the Bureau of Entomology at the Interstate Beekeepers' Meeting held at Hamilton, Illinois, in August.

The annual field day of the Eastern Massachusetts Society of Beekeepers was held on August 27 at the Norfolk County School of Agriculture. Walpole, Mass.

The Mississippi State Beekeepers' Association was organized at a meeting of beekeepers held at the A. and M. College on July 26. Mr. Clay Lyle of the College is secretary.

While on an extended trip through a number of the eastern states, Dr. E. F. Phillips visited the Bee Culture Laboratory of the Bureau of Entomology for several days in August.

The last session of the California legislature placed apiary inspection under the State Deparment of Agriculture. Beginning August 1, 1927, this work will be in charge of Frank E. Todd, Entomologist of the Department, Sacramento, Calif.

The Connecticut Beekeepers' Association held its summer meeting at the Connecticut Agricultural College, Storrs, on July 26 and 27, during Farmers' Week. The principal speakers were Dr. E. F. Phillips, Dr. Philip Garman, Professor L. B. Crandall, and Mr. Allen Latham.

Senor Demetrio D. de Torres Y de Quirós, Ingeniero Agrónomo, Del Musea Nacional de Ciencias Naturales, Madrid, Spain, who has just finished graduate work at Cornell University in economic entomology, consulted with various members of the Bee Culture Laboratory of the Bureau of Entomology in regard to apicultural work in this country.

The Alabama Beekeepers' Association held a meeting at Auburn during Farmers' Week, August 4 and 5. Forty-five were present, and Mr. George S. Demuth was one of the principal speakers from outside the state. A committee was appointed to work out a standard bee-shipping cage for the commercial breeders of bees and queens.

Mr. E. L. Sechrist of the Bureau of Entomology judged the bee and honey exhibit at the Ohio State Fair on August 29 and 30. The Ohio State Fair has one of the largest and best bee and honey exhibits in the United States. The exhibit this year was one of unusual interest because of the fact that the premium lists on honey were based on the United States' standard grades for honey, which have just been announced.

Dr. A. E. Lundie, formerly connected with the Bee Culture Laboratory of the Bureau of Entomology, and now Apiculturist of the Union of South Africa, in a recent letter reports that about five and a half times more beekeeping equipment was sold in South Africa in 1926 than in 1923. This gives an excellent indication

of the progress Dr. Lundie is making in promoting apiculture. He also says that the two United States Department of Agriculture films on beekeeping were shown in connection with the Witwatersand Agricultural Society Show in Johannesburg.

Indications point to the fact that the United States' Standard grades for honey are attracting considerable attention in a number of foreign countries. The following paragraph of a letter recently received from a domestic firm by the Bureau of Entomology indicates the receptive manner in which these grades are considered by the trade: "We appreciate very much indeed the work the U. S. Department of Agriculture has done in inaugurating uniform methods for grading honey, because heretofore you never knew what you received when you bought a certain quantity of honey; the opinions as regards color differed too much. We are now buying honey from the producers on basis of Department of Agriculture certificate final, and we are trying to make our European customers agree to the same terms."

Notes on Medical Entomology

Early in June, Mr. R. Glendenning, of the Agassiz, B. C. laboratory, directed oiling operations against mosquitoes breeding in extensive bush-covered swamps in the vicinity of Harrison Hot Springs.

Mr. Gonzalo Merino, of the Philippine Bureau of Agriculture, spent July 18 and 19 at the Dallas, Texas, laboratory of the Bureau of Entomology, studying the experimental work under way on insects affecting livestock and poultry.

An anti-mosquito campaign is now being conducted in New Haven, Conn. to raise funds to ditch certain salt marsh areas, some of which are in adjoining towns, in order to complete the work started fifteen years ago. Considerable ditching has been done in Connecticut during the past year, especially in the towns of Westport, Clinton, and Westbrook.

Mr. C. R. Twinn visited the Entomological Branch, Hawkesbury, Ontario, on July 25 and in early August, to investigate the origin of a serious local mosquito nuisance which persists until late autumn. Remarkable numbers of larvae of the European house mosquito, *Culex pipiens* L., were found developing in extensive stagnant back channels of the Ottawa river parallel to the town, where decomposing waste from a large sülphite pulp mill had destroyed the fish and produced ideal conditions for this species.

On July 13 and 14, Mr. F. C. Bishopp of the Dallas, Texas, laboratory of the Bureau of Entomology, attended the short course conducted by the Texas A. & M. College at the Medina-Hereford Ranch, and gave two talks, one on the control of external parasites of poultry, and the other on the control of the screw-worm, with special reference to the use of flytraps. Early in July Mr. Bishopp spent some time going over the organized screw-worm control area in Menard County, Texas, and incidentally discussed the screw-worm and the use of fly traps on the range before a meeting of stock men held at the Martin Ranch, under the auspices of the Texas A. & M. College.

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SOME EFFECTS OF ALTERNATING TEMPERATURES ON THE GROWTH AND METABOLISM OF CUTWORM LARVAE[1]

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ABSTRACT

The first part of this paper presents the results of experiments in which larvae of *Porosagrotis orthogonia* Morr. were reared with daily alternations of high and low temperature. It was found that growth was accelerated by these alternations, the highest acceleration being for an eight hour exposure to high temperatures.

In the second part of the paper, experiments are discussed in which the metabolism of larvae of *Chorizagrotis auxiliaris* Grt. was measured after varying exposures to high temperatures. Here also it was found that metabolism, as measured by carbon dioxide output, also showed a maximum for an eight hour exposure.

Both sets of experiments are discussed in relation to current chemical theories, and a time-temperature-rate surface is developed which shows the general relationship.

INTRODUCTION

There are many generalizations scattered through the literature regarding the stimulating effects of varying temperatures, but there are very few experimental data available. All workers with temperature recognize that a constant temperature has a different effect upon growth and metabolism than a varying temperature with the same mean value. Some recent experiments of J. R. Parker (unpublished) upon *Melanoplus atlanis*, in which he exposed hoppers to two different constant temperatures each day, were very suggestive, and the search for an explanation led me into the investigations which are presented here.

Many years ago, Blackman (1905), working upon the carbon assimilation of green leaves, developed a theory to explain the effects of short exposures to high temperature upon plant metabolism. He exposed cherry laurel leaves to high temperatures and measured their carbon assimilation after various periods of time, and he reached the following conclusions:

[1]Contribution from the Entomology Department, Montana Agricultural Experiment Station.

"1. At high temperatures (30°C and above for the leaves of cherry laurel) the initial rate of assimilation cannot be maintained, but falls off regularly.

"2. The higher the temperature the more rapid is the rate of falling off.

"3. The falling off at any given temperature is fastest at first and subsequently becomes less rapid."

Below 25° he found no falling off in carbon assimilation with time. He assumed that the rates for any period at these lower temperatures would fall on an exponential curve, following van't Hoff's law. He calculated a curve to fit these, and extended it up to the thermal death point of the plant. He then assumed that this curve represented the theoretical initial high value for each temperature, which fell off so rapidly as to be incapable of measurement, reaching in a short time the lower values actually found. As a corollary of his main proposition, he assumed a temperature at which the drop would be so rapid as to reach zero within any specified short time, and hence could not be measured. This point, the upper thermal death point of the organism, he called the "extinction point."

Kanitz (1915, p. 20) discusses this work of Blackman in detail, and disagrees with his conclusions, but this conception of the interrelation of time and temperature has proven so helpful in chemical work that Bayliss (1913) uses it as a "complete explanation" of the effects of these factors upon enzyme reactions.

Experimental Work

Two sets of experiments were performed during the winter of 1925–26 with the object of testing the value of Blackman's theory in interpreting the facts of insect growth and metabolism. The first experiments were planned to find the effects of alternating temperatures upon growth, and larvae of *Porosagrotis orthogonia* Morr. were used. The second experiments were planned to check the actual metabolism of the insect during exposures to high temperatures, using the carbon dioxide output as an index of metabolic rate. The method used required a large number of larvae, and the supply of *Porosagrotis orthogonia* was limited, so larvae of *Chorizagrotis auxiliaris* Grt. were brought in from the field. The use of two species obviously precludes a direct check between the two sets of experiments, but it has the advantage of allowing comparison between species, to bring out common features in the results.

I. The Effects of Alternating Temperatures Upon the Growth of Larvae of *Porosagrotis orthogonia* Morr.

The stock used in these experiments came from eggs laid by females captured in the fall of 1925. These eggs were developed nearly to the

hatching point and then held at 0°C until needed. A few hours exposure to room temperature in the presence of moisture caused them to hatch.

The newly hatched larvae were divided into lots of eleven each. Seven such lots were placed at constant temperatures of 12°, 16°, 22° 27°, 32°, and 37°C., to serve as checks. Other lots were then taken for exposure to alternating temperatures. For high temperatures 22°, 27°, 32°, and 37° were used, while 8° served as the low temperature for all lots. Four lots were placed at each high temperature, one each for two, four, eight and sixteen hours per day. The remainder of the day was spent at 8° in each case. Additional lots were placed at the two higher temperatures for one hour per day and spent twenty-three hours at 8°. The larvae were all examined daily at the close of the exposure to high temperature, and all molts noted. Under these conditions, especially in those lots exposed to high temperatures for four hours or less per day, the larvae developed rather slowly. In order to limit the duration of the experiment the length of the first instar was taken as the growth period.

Table 1 presents the experimental results, giving the total hours, both at high and at low temperature, required for each lot to complete the first instar. These figures are mean values for the surviving larvae of each lot. At least nine larvae lived through the experiment in every case except at 37°, where five larvae survived a daily exposure of eight hours, and eight one of four hours daily.

TABLE 1. DURATION OF FIRST INSTAR OF *Porosagrotis orthogonia* AT CONSTANT AND AT ALTERNATING TEMPERATURES

Hours per day at High Temperature	24	16		8		4		2		1	
High Temperature Degrees C.	Check	Total Hours at High	Low	Total Hours at High	Low	Total Hours at High	Low	Total Hours at High	Low	Total Hours at High	Low
12	462.0										
16	212.6										
19	138.0										
22	118.8	97.6	40.8	75.2	134.4	67.2	316.0	54.6	578.6		
27	78.0	74.5	29.3	58.4	100.8	51.0	235.0	42.6	446.6		
32	66.0	56.8	20.4	52.4	88.8	45.4	200.0	35.6	369.6	27.8	616.4
37	Died	Died	Died	80.0	144.0	60.0	280.0	46.0	484.0	31.0	690.0

Growth rate, for the purpose of these experiments, is defined as the reciprocal of the time required to complete the first instar, or, the value of one hour at a given temperature. A larva which molted after one

hundred hours at 22°, for example, would have a growth rate of 0.01. In the alternating temperatures the calculation of growth rate is complicated by the necessity of allowing for the slight amount of growth per hour which occurred during the time spent in the cold. Growth at a

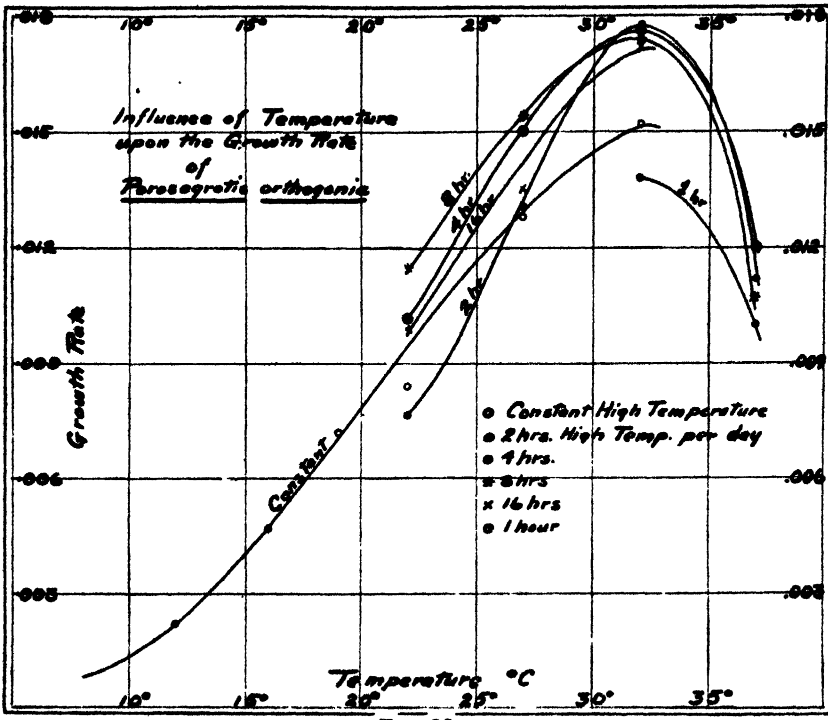

FIG. 26

constant temperature of 8°C is very slow. Larvae of this species have been found to live at 8° for considerable periods, but very little feeding occurs. The time spent at 8° is very large in some cases, however, and a considerable total growth must have occurred. An inspection of the curve labeled "Constant" in Figure 26 shows that the value 0.001 is not far from the probable growth rate at 8°. Assuming this value, a sample calculation follows:

The larvae exposed to 22° for 16 hours daily molted after 97.6 hours at 22° and 40.8 hours at 8°. (Table 1).

Total development = 1.0000

40.8 hours at 8° (value 0.001) = 0.0408

By subtraction this leaves 0.9592 for the value of 97.6 hours at 22°.

Hence, the value of 1 hour at 22° = 0.0099 which is taken as the growth rate for this lot.

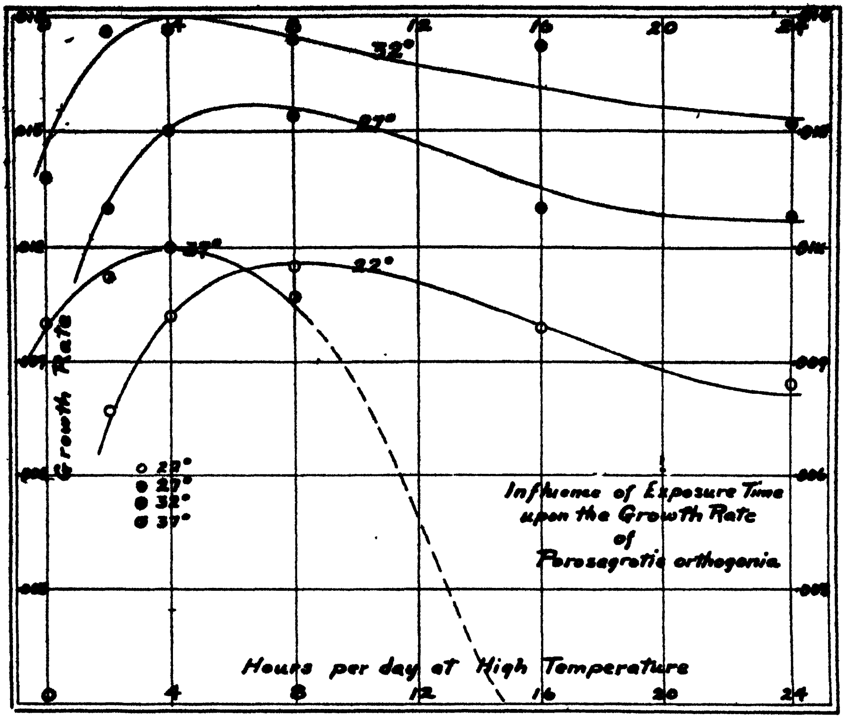

FIG. 27

The growth rates were so calculated for each lot in the series, and are presented in Table 2 together with the growth rates of the larvae held at constant temperatures.

TABLE 2. GROWTH RATE FOR FIRST INSTAR OF *Porosagrotis orthogonia* AT CONSTANT AND AT ALTERNATING TEMPERATURES

These values are calculated from the times in Table 1, assuming .001 as the value of one hour at eight degrees Centigrade.

Hours per Day at High Temperature	24	16	8	4	2	1
High Temperature Degrees C.	Figures below give the value of one hour at high temperature					
12	.0022					
16	.0047					
19	.0072					
22	.0084	.0099	.0115	.0102	.0077	
27	.0128	.0130	.0154	.0150	.0130	
32	.0152	.0172	.0174	.0176	.0177	.0138
37	——	——	.0107	.0120	.0112	.0100

These growth rates are plotted against temperature in Figure 26, and against hours per day at high temperature in Figure 27. Quite evidently the curves of Figure 27 do not follow Blackman's theory, for the initial value is not the highest, and there is an interval of several hours before the maximum rate is reached. Further discussion is postponed until the data from metabolism experiments with *Chorizagrotis auxiliaris* are presented.

II. The Carbon Dioxide Output of Larvae of *Chorizagrotis auxiliaris* Grote During Exposures to High Temperatures

These experiments were planned to check the growth experiments of the first series, and to find what actually occurs during the exposure to high temperature. The determinations were made by a modification of the titration method of Lund (1919).

Single larvae were suspended in tightly corked bottles containing 10 cc. of N/100 barium hydroxide for a period of twenty minutes (22°C and above) or one hour (below 22°C). At the end of this period the larvae were removed and the excess barium hydroxide titrated with N/200 hydrochloric acid. Two blank bottles in each set gave the correction for carbon dioxide in the confined air, and that given off by the larvae in the other bottles was found by difference. The larvae were weighed after each experiment, and the results calculated in terms of carbon dioxide given off by one gram of larva in one hour. To avoid cumbersome decimals, these results have been multiplied by 1000, giving grams carbon dioxide per kilogram of larva per hour.

Experiments were run in sets of ten, each set containing eight larvae and two blanks. The larvae used weighed from 0.3 to 0.9 gram each. The results recorded here are the average of at least sixteen larvae for each determination. In most cases thirty-two were used.

The experimental procedure follows: Well fed larvae were placed at 0°C for from sixteen to forty hours, but rarely longer. They were then placed in warm bottles at the desired temperature and their carbon dioxide output determined at once. After weighing, they were allowed to feed at the high temperature for the remainder of the experiment, the feeding being interrupted at intervals for further carbon dioxide determinations. The exact time schedule of a typical experiment follows.

8:00 a. m.	Larvae taken from refrigerator	
8:00– 8:20	CO_2 determination at 32°C.	(designated 0 value)
8:20– 9:00	Allowed to feed at 32°	
9:00– 9:20	CO_2 determination	(designated 1 hour value)
9:20–10:00	Allowed to feed	
10:00–10:20	CO_2 determination	(designated 2 hour value)
10:20–12:00	Allowed to feed	
12:00–12:20 p. m.	CO_2 determination	(designated 4 hour value)
12:20– 4:00	Allowed to feed	
4:00– 4:20	CO_2 determination	(designated 8 hour value)
4:20– 8:00 a. m.	Allowed to feed	
8:00– 8:20	CO_2 determination	(designated 24 hour value)

For determination of metabolic rate after a sixteen hour exposure, a separate set of larvae was necessary. They were usually taken from the refrigerator at 5 p. m., a "0" determination made, and then they were allowed to feed at the high temperature until 9 a. m. the next morning, when the sixteen hour determination was made.

These determinations give the actual value of the metabolism at the time of measurement, and show what actually takes place during the exposure period. They are tabulated in Table 3. They have also been plotted against time at high temperature in Figure 28. The curves at 8°

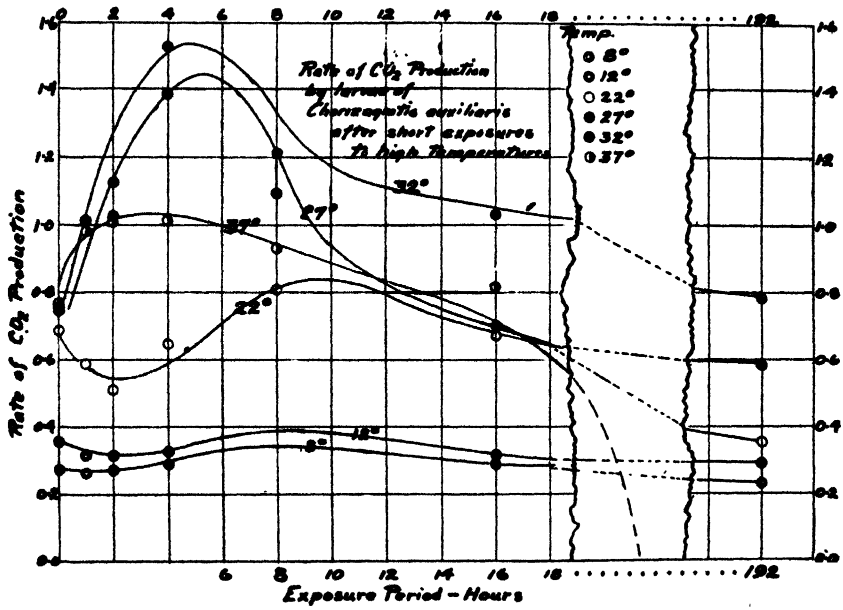

FIG. 28

and 12° are approximately straight lines. At 22° there is an initial drop, of unknown significance, followed by a rise to a maximum after eight hours, and then by a steady decline to the final value. At 27° and 32° the maximum comes after about four hours, and at 37° it falls between two and four hours. The 37° curve falls to zero in about 150 hours, as this exposure usually kills the larvae.

At the intermediate temperatures it is seen that the metabolism rises in a few hours to a high value, about twice that attained under constant conditions. If the growth is checked by cooling to near the point of dormancy, and the larva is again exposed to the high temperature, this is repeated, and an accelerated growth rate maintained.

TABLE 3. RATE OF CARBON DIOXIDE PRODUCTION OF LARVAE OF *Chorizagrotis auxiliaris* AT THE END OF VARIOUS SHORT EXPOSURES TO HIGH TEMPERATURES

Temperature	Exposure Period in Hours						
Degrees C.	0	1	2	4	8	16	192
8	0.277	0.269	0.276	0.285		0.294	0.216
12	0.359	0.313	0.315	0.325		0.315	0.292
22	0.688	0.588	0.507	0.642	0.808	0.676	0.359
27	0.755		1.026	1.388	1.097	0.696	0.585
32	0.748	1.017	1.121	1.530	1.209	1.032	0.782
37	0.762	0.988	1.010	1.019	0.935	0.814	Died

The figures in this table are in terms of grams carbon dioxide given off in one hour by one kilogram of material.

In order to compare these curves with the growth curves of the first experiment, it is necessary to recalculate the results in terms of average CO_2 production during periods of one, two, four, eight and sixteen hours. This is done by reading the intermediate ordinates on the curves of Figure 28 and obtaining an average value for the desired period. These average rates of metabolism have been computed, and they are given in

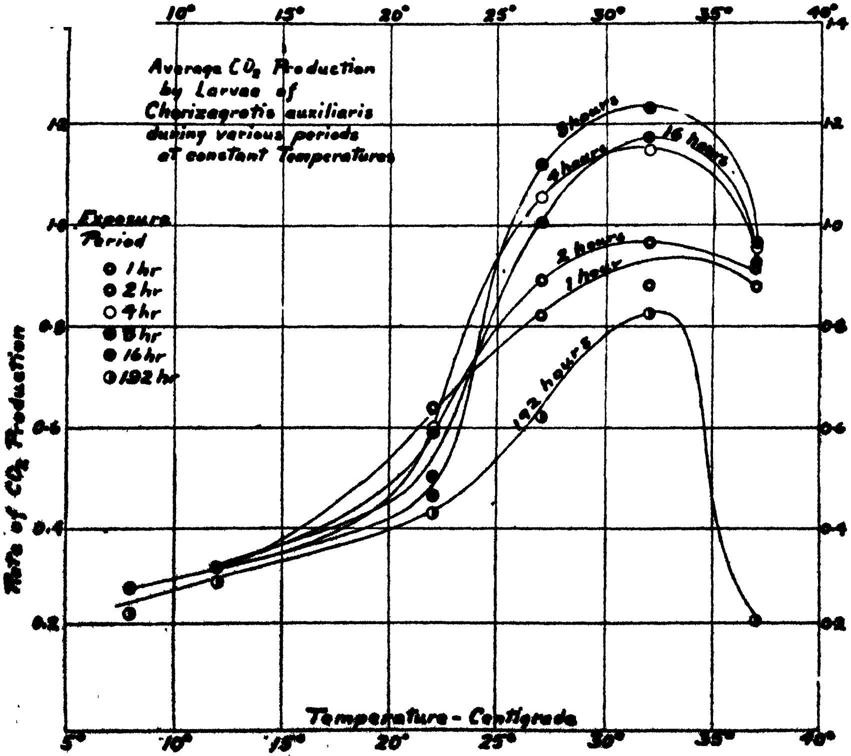

FIG. 29

Table 4. They are shown plotted against temperature in Figure 29, and against length of exposure period in Figure 30.

TABLE 4. AVERAGE RATE OF CARBON DIOXIDE PRODUCTION BY LARVAE OF *Chorizagrotis auxiliaris* DURING SHORT EXPOSURES TO HIGH TEMPERATURES

Temperature	Exposure Period in Hours								
Degrees C.	1	2	4	8	16	24	48	96	192
8	0.273	0.275	0.280	0.284	0.288	0.282	0.262	0.242	0.229
12	0.336	0.325	0.323	0.325	0.323	0.319	0.312	0.304	0.298
22	0.638	0.594	0.600	0.665	0.701	0.680	0.615	0.523	0.441
27	0.822	0.890	1.053	1.121	1.004	0.890	0.747	0.669	0.631
32	0.883	0.962	1.148	1.229	1.173	1.104	0.982	0.891	0.837
37	0.875	0.920	0.959	0.962	0.921	0.850	0.637	0.406	0.000*

*Larvae die in about 150 hours at 37 degrees C.

The figures in this table are in terms of grams carbon dioxide given off in one hour by one kilogram of material.

A direct comparison of these curves with Figures 26 and 27 shows that the same forces are at work in both cases. Both curves show a gradual rise to a maximum in four to eight hours, followed by a more gradual drop. The experimental error is high in both cases, but is higher in the growth curves than in the metabolism curves, as the number of larvae is smaller in the growth experiments.

DISCUSSION

In order to reach a sound theoretical basis for the interpretation of these curves, it is necessary to view the problem from the standpoint of enzyme chemistry. The first point of similarity between the insect growth and metabolism curves and curves for the rate of reaction of enzymes is found in the general shape of the limiting curve, labeled "*Constant*" in Figure 1, and "*192 hours*" in Figure 29. This curve rises rather slowly at first, then rapidly approaches a maximum, where it slows to a standstill and then rapidly drops to zero. Figure 31 shows a similar curve for the effect of temperature upon the activity of wheat diastase, from data of Rumsey (1922).

In accordance with the general theory of Blackman (loc. cit.) this curve may be explained as a balance between an increasing rate of activity on the part of the enzyme and a similarly increasing rate of destruction of the enzyme at high temperature, which finally results in total destruction of the enzyme within a short period. At temperatures below the upper thermal death point the activity does not reach zero, but declines to a low constant value. This value is generally interpreted as representing an equilibrium between production of new enzyme and inactivation, in the case of the enzyme reaction, and might possibly

be interpreted as a similar equilibrium between rate of production of new tissue and the elimination of waste products, in the case of the insect.

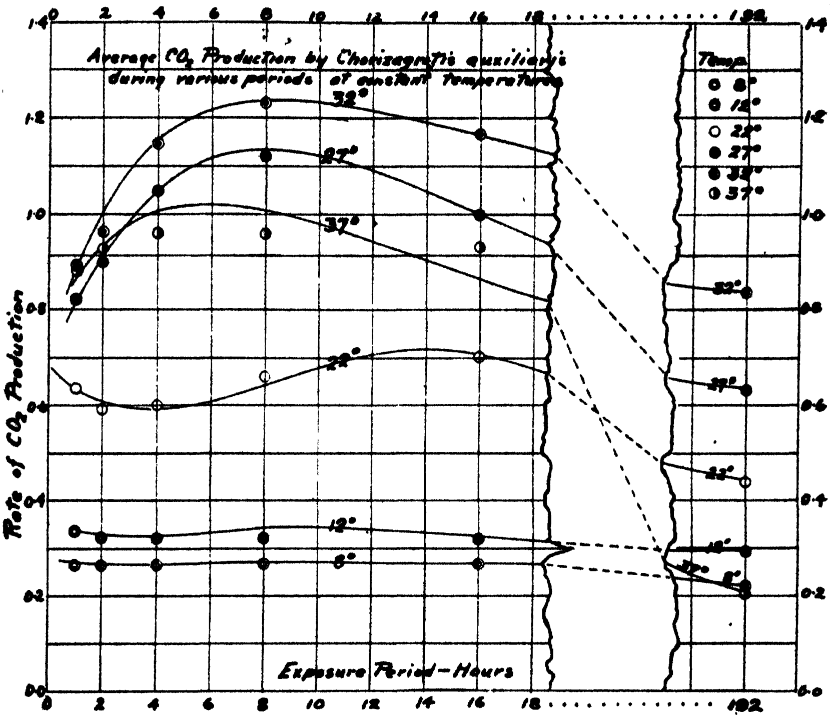

FIG. 30

Crozier (1924 and elsewhere) has shown that the chemical equation of Arrhenius:

$$K^{1} = K_{n}\, e^{\frac{a}{2}\left[\frac{T_1 - T_0}{T_1 T_0}\right]} \quad \ldots\ldots\ldots\ldots \quad (1)$$

holds for the effects of temperature upon many physiological reactions. In this equation, K_0 and K_1 are the rates of reaction at the two absolute Centigrade temperatures T_0 and T_1, e is the base of the natural system of logarithms, and a is a constant determined from the data, which Crozier designates the "critical thermal increment." Arrhenius interprets a as the heat necessary to activate 1 mol of inactive substance. It is theoretically a constant for any given reaction, and may be used to calculate the rate of reaction K_x for any temperature, when K_0 has been found.

Assuming that the growth curves are the resultants of opposing reactions, it should be possible to fit two such curves as (1) to the data, and reproduce the experimental curve. The resultant curve would be of the form

$$K_1 = K_0 [e^{\alpha} + e^{\beta}] \quad \ldots\ldots\ldots\ldots \quad (2)$$

in which α and β represent two exponents of the form of that in equation (1), with different values of the constant a. Janisch (1925) has recently set forth a theory for the explanation of physiological reactions of all kinds, naming the generalization the "Exponential Law" or "Exponentialgesetz." He postulates that the general form of the growth curve is that of a catenary, the special curve formed by any flexible object suspended loosely from the two ends. The catenary has the formula.

$$Y = \frac{a}{2} (e^{x/a} + e^{-x/a}) \quad \ldots\ldots\ldots\ldots \quad (3)$$

and is symmetrical. By substituting a second constant b in place of the second a in the formula an asymmetrical curve is formed, which can be made to approach many types of experimental curves. The general form of equation (3) is similar to that of (2), but the theoretical basis of (2)

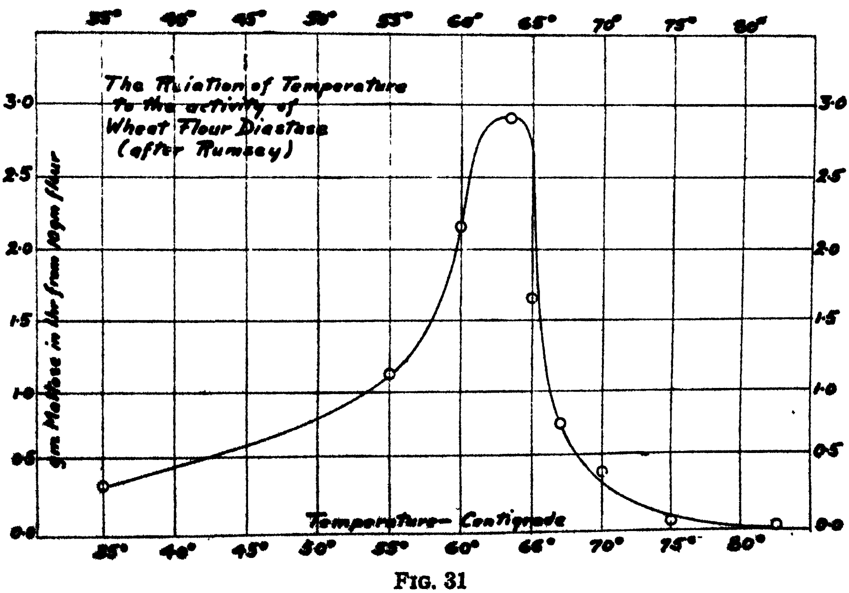

FIG. 31

is more sound, and connects these physiological reactions more closely with chemical theory.

Considering now the influence of time on the rate of metabolism, a similar line of reasoning may be used. A larva taken from a cold room and warmed rapidly might conceivably follow an exponential curve in its rate of metabolism until a point is reached at which a limiting factor,

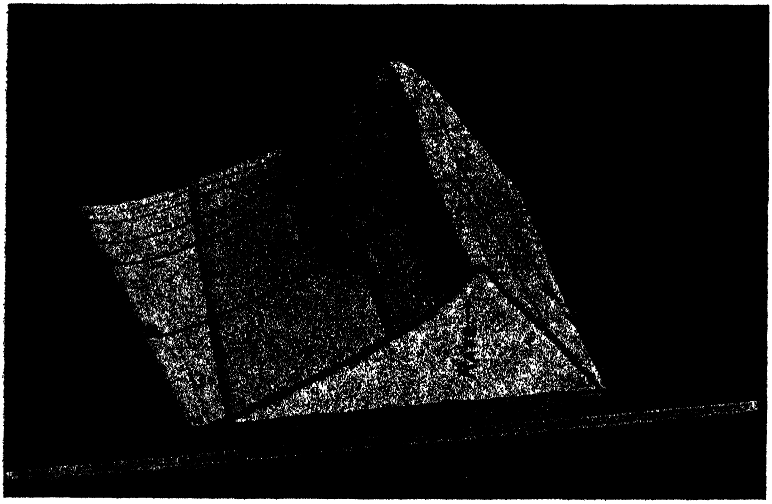

FIG. 32.—Time-temperature-growth. Model for *Chorizagrotis auxiliaris* Grt.

such as disposal of waste products, slows the chain of reactions. This limiting factor would probably follow the same course, and we would have a compound curve somewhat similar to that of equation (2), with time substituted for temperature.

The mathematics of the subject is complex, but it is evident that a combination of the rate, temperature and rate, time curves would give a three-dimensional surface including the three factors rate, time and temperature. In order to show some of the properties of the time-temperature-growth surface, a model has been constructed from the data of Table 4. Time and temperature form the horizontal axes, with metabolic rate as the vertical axis. This model has been photographed in Figure 32. The time scale is shown along the left hand margin, and the temperature scale is along the edge in the foreground, low temperature to the left, and high temperature to the right. The obser-

vations have been smoothed in constructing the model, but no important irregularities were omitted.

Several interesting points are to be noted. The limits in time are (*a*) the theoretical curve for instantaneous exposure, (which is *not* an exponential curve of the van't Hoff type, as expected by Blackman), and (*b*) the curve obtained by holding under constant conditions. Curve *a* starts at the lower thermal death point, and ends at the upper thermal death point. Curve *b* starts at the lowest temperature at which perceptible growth occurs, and ends at the lower limit of heat dormancy or aestivation. The temperature zone between the lower limits of curves *a* and *b* is the zone of dormancy, and that between their upper limits is the zone of aestivation. The point of most rapid metabolism (for this species) lies in the vicinity of 32°C, becoming slightly higher as the exposure time is shortened. The exposure time for most rapid growth *per hour* is about eight hours near 32°, lengthening below this temperature and shortening above. It is very significant that combinations of time and temperature of these approximate values are very common during spring and summer in the temperate zone. Temperatures above 32° are rarely prolonged more than a few hours, while temperatures between 15° and 20° commonly occur for quite long periods. The temperature-time optimum is strongly marked at high temperatures, while at low temperatures the curve is nearly flat, and shows little change with time. Above the zone of most rapid growth the optimum is still marked, but approaches the zero of the time scale, and the fall becomes more rapid until the whole curve disappears at the upper thermal death point.

The surface may be regarded as a direct combination of two sets of curves; the growth/time curves, with a point of most rapid growth for each temperature, and the growth/temperature curves, with a temperature of most rapid growth for each time interval. At the point where these two lines of most rapid growth intersect is the temperature/time optimum, or point of absolute maximum growth. This is the peak of the model.

SUMMARY

Two sets of experiments are presented, which were planned to determine the effects on growth and metabolism of alternating high and low temperatures. One set gives the rate of growth of first instar larvae of *Porosagrotis orthogonia* when exposed to various high temperatures for short periods per day, and the other set gives the rate of carbon dioxide production by nearly mature larvae of *Chorizagrotis auxiliaris*, during similar exposures.

Both experiments point to the same conclusion: In working with temperature it is necessary to consider the time of exposure. They show that larvae removed from a cold room to a warm incubator gradually accelerate their metabolism for several hours, after which their metabolic rate gradually declines over two or three days to a lower constant figure. The combinations of time and temperature which produced most rapid metabolism in the cutworms used were those which are very common in the temperate zone during the growing season.

These results are interpreted as being the resultants of opposing forces. In considering the relation of temperature to metabolism, the two forces concerned may conceivably be the increased activity and increased destruction of enzymes at high temperatures. In considering the relation of time to metabolism, the two forces might be the production of new tissue material and the elimination of waste products. In both cases an equilibrium is reached.

A combination of the time-temperature-metabolism curves gives a three-dimension surface, from which the rate of metabolism or growth for any time-temperature combination may be predicted. This surface has the following properties:

(1) An optimum combination of time and temperature for the given species; a point at which the rate of growth reaches its highest absolute value.

(2) A shift in the time position of the optimum line with changes in temperature, the optimum time being shortened at higher temperatures.

(3) A series of zones of equal growth rate, surrounding the absolute time-temperature optimum. This makes it possible to secure any given growth rate less than the maximum by several combinations of time and temperature.

(4) A correlation of the limits of growth in time and temperature with the zones of dormancy and the thermal death points.

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A PRELIMINARY REPORT ON THE FACTORS CONTROLLING THE OVIPOSITION OF MAY BEETLES IN MINNESOTA (*PHYLLOPHAGA, SCARABAEIDAE, COLEOPTERA*)[1]

By Harvey L. Sweetman, *Minnesota Agricultural Experiment Station*

Introduction

Several areas in southern Minnesota suffered from severe outbreaks of white grubs in 1924–25. This paper is a preliminary report of the factors controlling oviposition in Minnesota as determined from the presence of grubs in 1925 and eggs and beetles in 1926.

Analysis of Literature

The May beetles are a difficult group to study, having a two to four year life cycle and spending all but a few weeks of this time in the soil. This latter brief period of the adult stage is an alternation between life in the soil in the daylight and above soil at night. As a result very few workers have attempted extended studies. The principal publications, dealing with the subject taken up in this paper are by Criddle (1918), Davis (1916, 1918, 1922), and Forbes (1894, 1907, 1916a, 1916b).

Criddle says that May beetles are not found on the treeless plains of Manitoba. He found *P. anxia* an inhabitant of rich lowlands in the vicinity of willow inhabiting areas while *P. drakei* preferred sandy soils in higher and more open situations for breeding places. Regarding oviposition he states: "Grass lands are especially attractive to June beetles for egg laying purposes, and should there be any of these insects in the neighborhood they are sure to be found breeding in such places." No data is given as evidence for his conclusions.

Davis (1916) states: "We know the beetles prefer a ground covered with vegetation for the deposition of their eggs, hence, other conditions being equal, most of the eggs will be laid in timothy, blue grass, and small grains." He further says that "ground which was kept thoroughly cultivated during the flight of the beetles will be comparatively free of eggs." In 1918 he emphasizes that "there are no authentic records of injury to such crops as alfalfa and clover" and also says "the beetles prefer to deposit their eggs in ground covered with vegetation in the immediate vicinity of timber, usually choosing for this purpose the more elevated spots." The 1922 paper is a short summary of previous conclusions and is of interest only as a recent affirmation of former conclusions. Apparently most of his observations regarding places of oviposition are based on the years of injury and thus were made two or three years after the eggs were laid.

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Forbes' papers contain more ecological information dealing with physical factors than others. In 1894 he makes these statements: "It is now well settled that at least some species of the white grubs may be freely and abundantly bred in fields of corn. . . but it still remains true. . . that corn is much more likely to be damaged if planted on sod than if it follows clover, some small grain, or corn itself. We have no evidence that the eggs of the June beetle are ever laid in clover. It is well known that a surface growth of vegetation is a strong attractant to these insects searching for places suitable for the support of the young." In 1907 he says regarding the collection of grubs in 1904 and 1905: "They show that the grubs were more abundant on the higher and drier parts of the country than on lower and moister parts, and that the fewest eggs were laid by the parent beetles in the corn fields and most in grass lands." Later this statement is found: "While the old idea that white-grubs are essentially insects of pastures and meadows has been exploded by observations of recent years, it still remains true that, other things being equal, they are most abundant in grass-lands." In another paper (1916b) Forbes gives data showing the relationship of trees to infestation and the numbers of grubs in various crops. Fallow land was third in numbers of grubs found, but he says this was "grown up of course to weeds, largely grasses." On the next page: "The predominance of grasses and small grains over corn and other crops as a lure to May beetles about to lay their eggs is unmistakable." These conclusions regarding *selection* of fields for egg laying are taken from the *presence* and *survival* of grubs two or three years after the eggs were laid. The writer does not know of any publications giving data to show that the beetles select or that eggs are not laid in fallow land free of vegetation that was made *while the adults were flying*.

Life History

The May beetles of Minnesota emerge in the spring and oviposit in the soil. The eggs hatch in two to four weeks into small grubs that feed upon the roots of the vegetation for two to four years. Then the larvae pupate in the soil from a few inches to two feet deep and transform into adults the same year. They remain as adults in the pupal cell until the following spring. A few species migrate downward in the fall after transformation.

Acknowledgments

Acknowledgments are due Dr. R. N. Chapman, Dr. W. C. Cook, and Prof. A. G. Ruggles of the Department of Entomology at the University of Minnesota and to Prof. J. J. Davis, Head of the Department of Entomology at Purdue University, Lafayette, Indiana.

A SURVEY OF THE WHITE GRUB INFESTATION LUVERNE MINNESOTA IN (1935)

Survey Methods

A survey was made in 1925 of the territory about Luverne, Minnesota, a district having more or less infestation for several years, to determine the influence of local factors and to correlate this with the known facts regarding oviposition. The data were secured from the farmers by personal interview and by making an examination of the fields following the interviews.

Species Present

The principle species concerned were *Phyllophaga fusca, P. implicita, P. rugosa, P. anxia, P. futilis, and P. drakei. P. fusca* requires three years for its life cycle in Kansas (Hayes, 1925) and Illinois (Forbes, 1916a; Davis, 1916); *P. anxia* three in Illinois (Forbes, 1916a) and four in Manitoba (Criddle, 1918); *P. drakei* three in Illinois (Davis, 1916) and four in Manitoba (Criddle, 1918); *P. rugosa* two and three in Kansas (Hayes, 1920); three in Illinois (Davis, 1916), and four in Manitoba (Criddle, 1918); *P. futilis* and *P. implicita* two and three in Kansas (Hayes, 1920) and Illinois (Davis, 1916). It is to be concluded from this that a three year cycle is probably correct for southern Minnesota. If this is true the damage in 1925 was produced by grubs from eggs laid in 1923.

Physical Factors

Crop History. The predominant rotation used by the farmers in this section is corn and oats in alternate years as stated above. Davis (1916, 1918, 1922) and Forbes (1894, 1907, 1916b) state that May beetles do not lay many eggs in cleanly cultivated or clover fields but that they prefer small grains and grass lands. Britton (1912) gives both grass lands and cultivated fields but says that they are more frequent in the former. The survey of 1923 crops at Luverne revealed 54 per cent of the corn fields, 52 per cent of clover fields, 44 per cent of oats fields, 37 per cent of clover-timothy fields, and 0 per cent of grass lands

Table 1. A Summary of the Crop History in 1923 of Fields Showing Infestation in 1925

1923 Crop	Total Acreage	Infested Acreage	Per cent of Infestation
Corn	7818	4193	54
Clover	372	192	52
Oats	5509	2419	44
Clover-timothy	392	147	37
Blue grass	141	0	0
Barley	103	103	100

contained grubs (Table 1). Only three fields of barley were concerned and all had high infestation. The lack of immunity of any crop indicates strongly that selection by the laying females is not an important factor.

ELEVATION AND SLOPE. It was thought that elevation and slope might have some influence, especially in over-wintering, upon the numbers of larvae present. Davis (1918) states that elevated areas containing vegetation are preferred for oviposition. Criddle (1918) lists *P. anxia* as an inhabitant of moist, rich lowlands in Manitoba while *P. rugosa* and *drakei* prefer higher and more elevated situations. Forbes (1907) says that more grubs are always found in high dry fields. In Minnesota upland showed infestation more frequently than lowland but apparently slope did not affect the numbers of grubs found (Table 2).

TABLE 2. A SUMMARY OF THE ELEVATION AND SLOPE OF FIELDS IN RELATION TO GRUB INFESTATION IN 1925

Elevation and Slope	No. of Fields	No. of Infested Fields	Per cent of Infestation
Upland...........	198	107	54
Lowland.........	64	22	35
North............	37	24	65
South............	95	53	56
East.............	36	19	53
West.............	30	11	37
Level............	64	22	35

SOIL SURFACE FORMATIONS. Soil types classified according to surface formations (Leverett and Sardeson, 1919) were about equally troubled (Table 3). Similar types of soils, rocky and gravelly, had the highest and lowest infestations. Davis (1916) states that most species prefer a clay-loam soil while Criddle (1918) mentions *P. rugosa* and *drakei* as inhabiting sandy soils. Criddle intimates that food plants might be the cause of this apparent selection.

TABLE 3. A SUMMARY OF SOIL SURFACE FORMATIONS OF GRUB INFESTED FIELDS IN 1925

Soil Type	No. of Fields	No. of Infested Fields	Per cent of Infestation
Rocky...........	72	44	61
Clay loam........	99	51	51
Silt loam.........	164	81	49
Gravelly.........	84	38	45

RELATION OF FOOD PLANTS TO INFESTATION

Trees are given by Forbes (1907, 1916b), Davis (1916, 1918, 1922), and Criddle (1918) as a very important factor in determining the degree of infestation. Criddle finds that May beetles are absent on the treeless

plains of Manitoba. A study of Table 4 shows that slightly over half of the fields without trees were infested but that two-thirds of the fields within an eighth of a mile of trees were attacked. Nearly three-fourths

TABLE 4. A SUMMARY OF FIELDS INFESTED WITH GRUBS IN 1925 WITH TREES WITHIN ONE-EIGHTH OF A MILE

Tree Data	No. of Fields	No of Infested Fields	Per cent of Infestation
With trees	141	93	66
Without trees	241	122	51
Cottonwood	32	24	75
Ash	29	20	69
Willow	40	26	65
Maple	11	7	64
Boxelder	20	9	45
Miscellaneous	9	7	78

of the non-infested fields, 117 of 167, were over an eighth of a mile from trees. Fields near willow, ash, cottonwood, and maple showed from 64–75 per cent infestation, while those near boxelder dropped down to 45 per cent. This is in accord with studies in 1926 at Jordan, Minnesota when boxelder proved unattractive to the species present. This shows a direct relationship between trees and grub damage but does not explain the high infestation away from trees. Forbes (1916b) has data to show that trees have very little effect beyond one-eighth of a mile. The high infestation away from trees in this region indicates that other plants besides trees are used for food or else flights of more than an eighth of a mile in length on returning to the soil in the morning take place. No evidence of long morning flights beyond this distance have been observed. In the spring of 1926 *P. anxia* was found to be a general feeder on woody and herbaceous plants, although the former were preferred. Probably other species can, if occasion arises, do likewise. Forbes (1907) states: "The discovery that certain species, at least, of the May-beetles may feed, and some do feed to a small extent, on corn and grass, and the consequent conclusion that they may not need convenient access to trees for food, raises the important question whether some of these insects, and possibly certain species of them, may not live continuously in the fields feeding on crop plants there and laying their eggs in the very places where they themselves originated." Hayes (1919) gives a long list of food plants, weeds and grasses, of one species that is independent of trees. Furthermore, Hayes (1920, 1925) in Kansas and Dawson (1922) in Nebraska give data showing the importance of herbaceous plants as food of May beetles.

STUDIES OF OVIPOSITION OF MAY BEETLES

The above survey made it evident that the outbreak in Minnesota could not be understood on the basis of present knowledge of oviposition responses. Trees explained the presence of grubs in many fields but this factor was far from giving a satisfactory explanation for the district. Further studies were undertaken in 1926 to investigate this problem at Jordan, Minnesota.

Species Studies

The species present in sufficient numbers to make careful studies with were *P. implicitia, anxia, fusca*, and *drakei*. *P. implicita* was the dominant form and the principal one studied. Other species present in fewer numbers were *P. futilis, nitida*, and *rugosa*.

Relation of Physical Factors to Oviposition

Factors Influencing Oviposition. According to Davis (1916, 1918, 1922) and Forbes (1894, 1907, 1916b) Phyllophaga do not oviposit to any noticeable extent in cleanly cultivated, alfalfa, or clover fields but prefer grass lands and small grains. Criddle (1918) and Britton (1912) give grasslands as the principal egg beds. No authentic records of injury to alfalfa and clover are known to Davis (1918). The writer found one field of alfalfa near Luverne, Minnesota that showed considerable injury from grubs in 1925. Davis also states that oviposition may occur in corn fields during cold periods when the beetles are unable to fly. A study of the temperature and the precipitation at Luverne in 1923 shows the spring to be drier than normal and unusually hot. The mean temperature in 1923 for May was +3° F. and for June +13° F. The precipitation for May was one inch and for June 2.8 inches below normal.

Egg counts and observations in 1926 of adults in corn, small grains, meadow, timothy, potato, and alfalfa plots were made throughout the season at Jordan, Minnesota. Between May 20 and June 11 twenty-six square feet of corn revealed 59 eggs while very few were found in small grains and grass lands. Because of the dry weather the soil was free of weeds and much of the corn did not sprout until after June 1, thus proving that vegetation is not a direct factor in location of oviposition. Grasses or small grains were within 50 feet of the places where any sample was examined. Beginning on June 26 and once a month thereafter five samples of soil of one square foot each were examined in each of the plots shown in Figure 33 and the data recorded in Tables 5 and 6.

TABLE 5. A SUMMARY OF SOIL EXAMINATIONS FOR EGGS AND GRUBS IN 1926

Plot No.	Crop	Sq. Feet Examined	No. of Eggs	No. of Grubs
1	Corn	20	62	45
2	Timothy	20	31	23
3	Blue Grass	20	0	8
4	Potato	20	18	15
5	Wheat	20	11	17
6	Corn	20	21	34
7	Alfalfa	20	1	37
8	Corn	20	5	94

TABLE 6. A MONTHLY SUMMARY OF SOIL EXAMINATIONS FOR EGGS AND GRUBS IN 1926

Date	Sq. Feet Examined	No. of Eggs	No. of Grubs
6-26-26	40	103	14
7-13-26	40	46	63
8-13-26	40	0	117
9-16-26	40	0	79

Other factors rather than selection were found to account for location and numbers of eggs found. In the season of 1926 the corn and potato land (Fig. 33; Plots 1, 4, 6, and 8) were free of weeds and contained much more moisture than meadow and small grains (Plots 2, 3, and 5). Plots 1–4 are comparable as they all bordered on the same grove of trees. All samples were taken at a uniform distance form the trees. Plot 1 in corn had twice as many grubs as timothy and over five times as many as blue grass. Both of the latter had hard, dry surfaces that the insects had difficulty in penetrating and they were often observed to fly on after failing to dig in. Some crawled 10 to 20 feet before giving up or finding a spot where the crust was broken (often my footprints). Plot 4 was heavily infested with ground beetle larvae which fed upon the grubs, destroying the majority of them before the August count. Plots 5 and 6 were side by side facing another grove. All samples were taken within 10 feet of the border line between the two plots. Again corn had twice as many grubs and eggs as the small grain crop. The wheat field had a loose soil but was very dry which was undoubtedly a reducing factor since the larvae were smaller and lacked the plumpness of those in the moist corn land. It is very doubtful if beetles will oviposit in a very dry soil and if they do the eggs are subjected to severe drying which may destroy them. Plots 7 and 8 are of particular interest as alfalfa is according to Davis (1916, 1918, 1922) and Forbes (1894, 1916b) unfavorable for oviposition. Plot 7 had the most grubs but was slightly nearer the trees. Most of the eggs had hatched when the first counts were made on June 26. The alfalfa land was low and moist enough to harbor the insects.

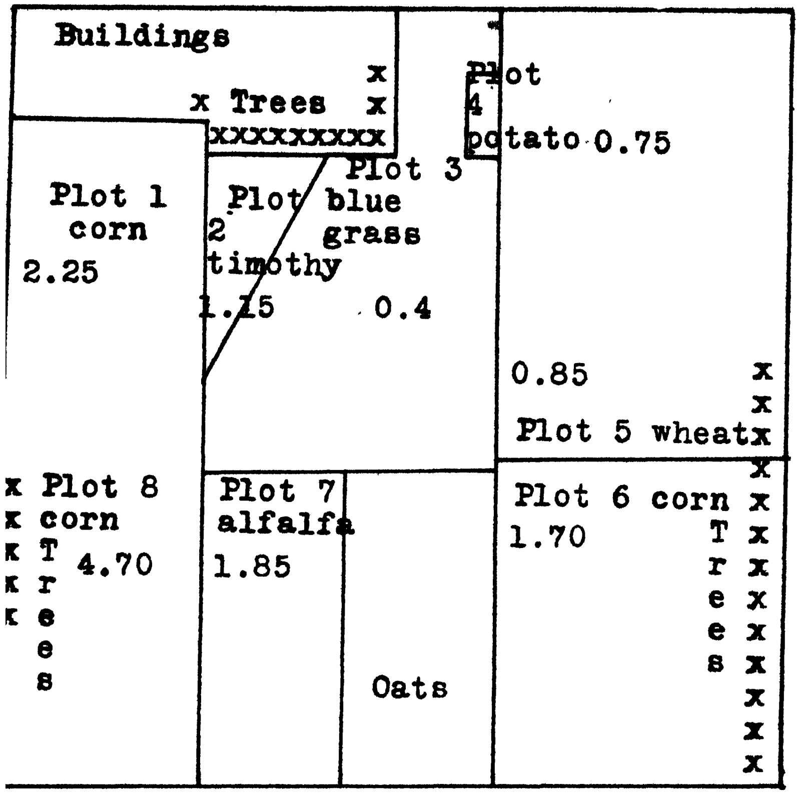

FIG. 33.—Diagram of farm at Jordan, Minnesota, showing arrangement of plots and the number of grubs per square foot

Repeated early morning observations when the beetles were returning to the soil failed to detect any selection on the part of the females of *P. implicita*, *fusca*, *anxia*, and *drakei*. The plots side by side (Fig. 33) in the immediate vicinity of food plants were corn and timothy, timothy and blue grass, blue grass and potato, corn and wheat, and corn and alfalfa. Narrow bordering strips of crops were watched and numbers of returning beetles in the morning and those emerging in the evening recorded. Some females, perhaps those which will oviposit during the day, leave the food plants one to three hours ahead of the major flight. Thus the period of return may extend over an hour or more. Forbes (1907) says the morning flight ordinarily lasts only ten to twenty minutes, but mentions days when the time was longer.

A study of Table 6 shows an increase in the number of larvae on the first three counts as eggs were hatching, while the last count on Septem-

ber 16 gave a decided reduction. Many of the grubs had started the downward migration on this date and time did not permit deep digging of all samples. The deepest larvae were over 2.5 feet below the surface.

TABLE 7. A SUMMARY OF SOIL EXAMINATIONS FOR GRUBS IN 1926 AT LUVERNE, MINNESOTA

Plot No.	Crop	Sq. Feet Examined	No. of Grubs	Grubs per Sq. Foot
1	Corn	15	9	3
2	Blue grass	10	0	0
3	Corn	20	16	4
4	Corn	10	13	6.5
5	Alfalfa	5	0	0

The influence of soil moisture and hardness of soil upon egg laying may be further illustrated by a study of a farm at Luverne, Minnesota, (Table 7 and Figure 34). In 1926 a large flight of beetles occurred in this area. A careful survey of one farm on September 4–5 was made. Plots 1, 3, and 4 in corn averaged from 3 to 6.5 grubs per square foot, while plots 2 and 5 in pasture and alfalfa were free of grubs. The trees across the road from Plot 1 were largely boxelder while willow and cottonwood were predominant along the other plots. The spring of 1926 was very dry in this section, making the soil in uncultivated plots very hard to penetrate and kept the infestation out.

The type of vegetation may sometimes be a factor in keeping the beetles out. Bent grass, *Agrostis stolonifera*, on a Minneapolis golf green was found to prevent *P. fusca* from burrowing in the sod because of the thick root mat.

Wind is also important as the beetles fly with the wind on returning to the fields in the morning.

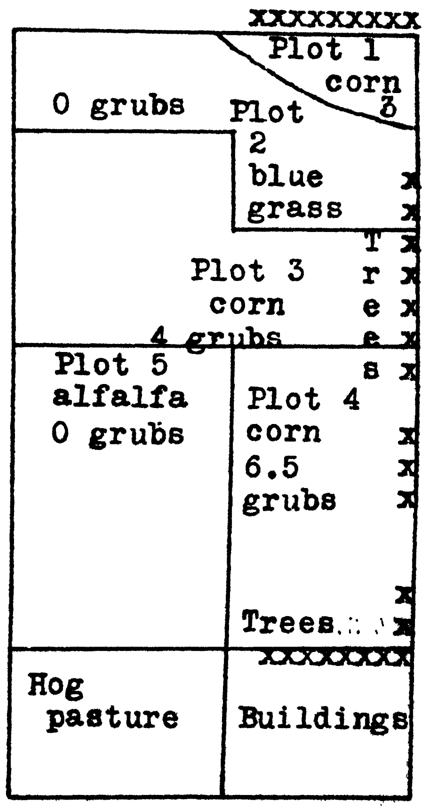

FIG. 34.—Diagram of farm at Luverne, Minnesota, showing arrangements of plots and the number of grubs per square foot.

On May 26 the flight was northward over grass land from the food plants with a wind that was from the south. The wind on June 6 was blowing in a southeastward direction and all beetles flew with the wind into a corn field from the same food plants as on May 26.

DELAYING EGG LAYING. Field observations indicated that the beetles did not select according to the surface covering on their return to the soil in the morning, yet the numbers of eggs and grubs were greatly reduced in these areas. This raised the probability that the females were able to withhold their eggs when in unfavorable places. In order to determine if Phyllophaga could delay egg laying three series of experiments were used (Tables 8, 9, and 10).

TABLE 8. EFFECT OF PRESENCE OR ABSENCE OF SOIL ON OVIPOSITION OF *P. implicita* CONFINED IN SIX OUNCE CANS

Temp. °C.	Soil Present	No. of Eggs
20	yes	15
20	no	0
25	yes	16
25	no	1

TABLE 9. EFFECT OF PRESENCE OR ABSENCE OF SOIL ON OVIPOSITION OF *P. implicita* CONFINED IN CLAY POTS

Temp. °C.	Soil Present	No. of Eggs
20	yes	19
20	no	0
25	yes	49
25	no	4

TABLE 10. THE EFFECTS OF PRESENCE OR ABSENCE OF SOIL ON OVIPOSITION OF *P. implicita* BY ALTERNATIVELY PLACING THEM IN AND ABOVE SOIL

Temp. °C.	No. ♀	Dates in Soil	Eggs When in Soil	Dates Above Soil	Eggs When Above Soil
22–25	5	Aug. 17	2	Aug. 18	0
		Aug. 19–21	5	Aug. 22–23	0
		Aug. 24–27	10	Aug. 28–31	0
		Sept. 1–7	3		
22–25	8	Sept. 10	2	Sept. 11–15	0
		Sept. 16–17	13	Sept. 18–20	1
		Sept. 21–24	8	Sept. 25–29	0

The cages used for this data in Table 7 were six ounce cans with covers, half containing soil and half without soil. Five females were placed in each and maintained at the respective temperatures for 20 days. At 20° C. and 25° C. the females that were laying when the experiment started continued laying in soil but only one egg was laid in the cages without soil. Newly emerged beetles did not start laying in

either case, perhaps because mating was interfered with in the small cages.

Six inch clay pots were used to secure the data recorded in Table 9. Six females were kept in each cage for 20 days. At 20° C. 19 eggs were laid in the cage with soil and none in the one without soil. In the 25° C. pots the results were 49 to 4 favoring the cage with soil. Again it is possible the eggs were destroyed in the cages without soil.

Table 10 gives the results when glass jars containing soil were used. The beetles were allowed freedom in the soil for a few days then screen was placed on top of the soil to prevent them from digging in for a few days. The screen would permit the eggs to pass through if any were laid while above the soil. The first cage in the table shows 20 eggs laid in 15 days in the soil and none in 7 days above the soil. The second cage shows 23 eggs laid in 7 days in the soil and one in 11 days above the soil.

Summing up the data in Tables 7, 8, and 9 show 142 eggs laid in favorable while only 6 were laid in unfavorable conditions. This shows that the adults can delay oviposition in unfavorable conditions. Furthermore, all dead beetles were dissected and some eggs, two of which hatched, were noticeable developed beyond the normal oviposition state. If this is true it is not unreasonable to expect females that find themselves in a very dry soil to withhold eggs until a more favorable condition is found.

Conclusion

The May beetles studied do not select places for oviposition according to the vegetational covering but fly at random from the food plants. Wind is usually not of importance in the evening but influences the direction of flight in the morning. Oviposition is in the immediate vicinity of food plants regardless of the elevation or type of soil when the physical conditions are suitable. If the soil is soft enough to permit digging and sufficient moisture is present the eggs are laid. Egg laying can be delayed at least 5 days when the beetles chance to get into unfavorable places. Probably many eggs and young grubs are destroyed in very dry soils. Cultivated land, as found in corn fields, satisfied the conditions for oviposition in Minnesota in 1926, while the physical conditions in small grains and grass lands did not. The evidence indicates the same conclusion to explain the results from 1923.

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IS GLUTATHIONE THE ARSENIC RECEPTOR IN INSECTS?

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ABSTRACT

This paper deals with the quantitative estimation of glutathione in normal insects and those after treatment with arsenicals of varying dilutions. Preliminary results indicate a variation in the normal glutathione content in different species. Those species subjected to arsenical treatment gave marked reduction in their glutathione content, presumably indicating that glutathione is an arsenical receptor.

Studies on the respiratory metabolism of insects have shown (1) that the normal rates of both the oxygen consumption and carbon dioxide output were greatly reduced (47%-55%) as a result of feeding or injecting with certain arsenicals. If we represent the oxygen intake and carbon dioxide output as ordinates and time in hours as abscissa, we find that the inhibition of the gaseous exchange may be graphically illustrated by a line the slope of which indicates the depression as a result of arsenical treatment (fig. 35). In previous work (2) it was

[1]The writer wishes to acknowledge the assistance rendered in the experimental work by H. Beerman, Field Assistant.

noted that the respiratory metabolism of normal insects decreased with age. In this case the curve (fig. 36) representing the decrease in the

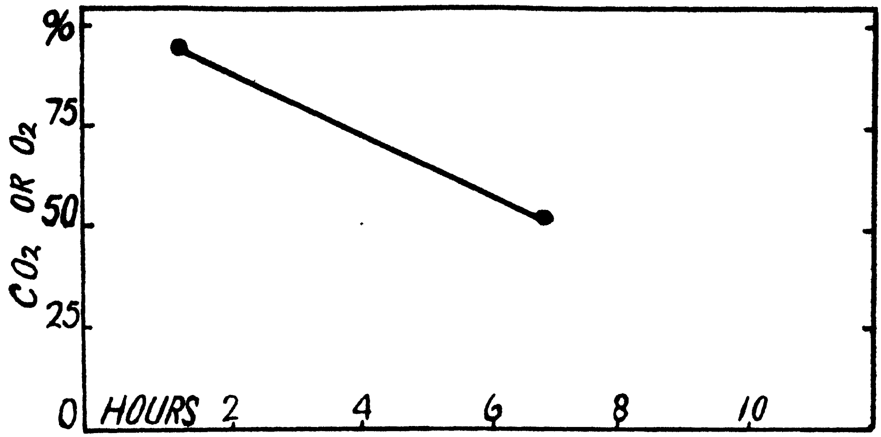

FIG. 35. The effect of arsenicals on the respiratory metabolism of insects.

gaseous exchange is a gradual one declining day by day for several months or more until the death of the insect. It is quite evident from these two illustrations that some substance in the protoplasm which is of great importance in the function of cell respiration, and normally is specifically concerned in a chemical defense of the body, is influenced by certain poisons. In one case (fig. 35) it is caused by the introduction of an external poison like arsenic in the body of the insect and in the other (fig. 36) by toxic substances probably produced within the body of the insect itself.

Several theories have been suggested to account for the mechanism concerned in cell reduction and oxidation. Nearly all animal tissues have the property of reducing sulphur to hydrogen sulphide, and the view maintained by Heffter (4) and others, is that the unstable hydrogen in the sulphydryl group - SH of living cells has important respiratory functions. Heffter, furthermore, applied the nitroprusside test to a large number of animal tissues and obtained a positive reaction which led him to suggest that the hydrogen of the - SH group was responsible, in part at least, for the reducing properties of protoplasm. He further suggested that in the cell some substance might act as an acceptor for the oxygen of the water molecule, leaving the hydrogen to reduce the disulphid group once more to the sulphydryl group, as in the following reaction,

$$SH{-}HS{-} \rightleftarrows {-}S{-}S{-} + H_2$$

According to Hopkins (5) this reversible reaction brought about by factors present in the cell itself has dynamic functions. Hopkins began a study of the substance responsible for the nitroprusside test in tissues and finally isolated a substance which proved to be a dipeptide composed of glutamic acid and cystein which he named "glutathione." According to Hopkins glutathione is responsible for the nitroprusside

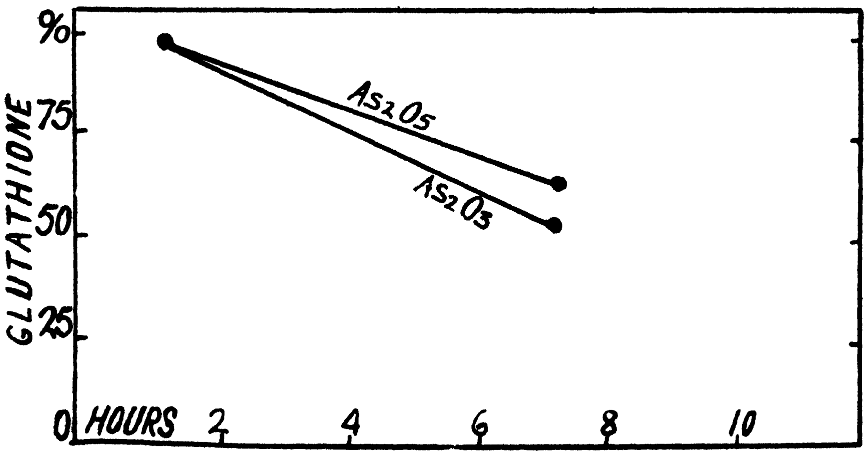

FIG. 36. The effect of age on the respiratory metabolism of insects.

reaction which is given by nearly all animal tissues and contains practically the whole of the non-protein, organically-bound sulphur of the cell. Glutathione acts readily under varying conditions as either a hydrogen or an oxygen acceptor. It can be both reduced and oxidized under the influence of factors shown to be present in the tissues.

That glutathione is of importance in the oxidation and reduction of cell respiration, Hopkins proved by the following experiment. Fresh tissue was thoroughly washed and boiled in water for several hours for the purpose of extracting all the glutathione. The residual tissue was afterwards dried, ground into a powder and placed in a Barcroft manometer, where it was determined that practically no respiration took place. However, if a little of this powder suspended in a dilute solution of glutathione was placed in a manometer, the material began to take up oxygen and give off carbon dioxide comparable to fresh tissue. This was experimental proof of the importance of glutathione in cell respiration.

In view of the inhibiting effect of arsenicals upon the respiratory metabolism of insects determined by the writer (1), it seemed worth while to test experimentally the effect of arsenicals upon the glutathione

content of insects. Among entomologists the opinion maintained is that different species of insects vary in their resistance to arsenicals. If that is true, it was reasoned, a greater glutathione content should be found in those species. It seemed desirable to determine this point as a clue to the presence of a receptor for arsenic in insect protoplasm.

Methods of Determining Glutathione

Two methods of determining the presence of glutathione in insects were used; one was qualitative, the other quantitative.

The qualitative was a micro method devised by the writer for the purpose of determining by aid of the nitroprusside test the relative distribution of glutathione in the tissues and organs of single insects. This method is described in Science (3) and the reader is referred to this article for further details.

The quantitative method for determining the actual amount of glutathione per gram tissue was described by Tunnicliffe (6) for yeast and animal tissue and was adopted for insect material.

Quantitative Method of Determining Glutathione

The tissue to be examined for glutathione is weighed and ground up with a little sand in a 10 per cent trichloracetic acid solution. After several hours it is filtered and the residue re-extracted several times with further amounts of the acid. The filtrates are combined, and an aliquot portion is used for titration with a 0.01N iodine solution, using several drops of a 5 per cent sodium nitroprusside solution or 0.5 per cent starch solution as an external indicator. Tunnicliffe found that 1 cc. of a 0.01N iodine solution was equivalent to 2.5 milligrams of glutathione; hence if one knows the amount of iodine required as a result of titrating the trichloracetic acid extract obtained from the tissue, it is possible from such data to calculate the amount of glutathione contained in one gram of tissue.

Trichloracetic acid, according to Tunnicliffe, gives an extract free from protein; does not precipitate glutathione or interfere with subsequent iodine titrations; and finally, owing to the acidity of the solution, the glutathione is not oxidized but remains in the reduced form as found in the tissue.

The Extraction of Glutathione From Insect Tissue. In normal animals 1 to 2 milligrams of glutathione is usually obtained per gram of tissue, and it is necessary to have at least 5 to 10 grams of tissue for a test. Insects, however, are particularly difficult material in which to determine glutathione owing to the presence of large amounts of chitin

and varying amounts of water to be taken into consideration when different stages of a species are used for comparison. It is essential, therefore, to use a large number of insects (50 to 100), depending upon the size of the species and the chitin content, in order to obtain 5 grams of tissue.

The approximate chitin content for each species is determined by first weighing a certain number of insects (50), dissecting and separating the tissue from the chitin, weighing the latter and calculating the per cent chitin present for each sex. Similarly the water content is determined by weighing a certain number of insects and afterwards dehydrating, and from the loss in weight obtained calculating the per cent of water for the species.

Experimental Procedure. To quantitatively determine glutathione the insects of a species under investigation are separated into sexes and left without food for several hours for the purpose of clearing the alimentary tract of as much waste and food material as is possible. From 50 to 100 insects of each sex are weighed on a balance to four decimals, afterwards cut up with a fine scissors and placed in a mortar with a little sand and about 10 cc. of a 10 per cent solution of trichloracetic acid, thoroughly ground up. Further amounts of the acid (20 cc.) are added and left for several hours in a stoppered flask to extract the glutathione. The material is then filtered and the residue re-extracted with additional amount of the acid (15 cc.), filtered again, and the combined filtrates are labelled for each species and sex. To determine the amount of glutathione, an aliquot portion (5 cc.) of the sample is drawn out by means of a fine pipette and placed in a beaker, to which are added several drops of a 5 per cent solution of sodium nitroprusside or 0.5 per cent solution of starch; this is titrated with 0.01N or 0.001N iodine solution.

The stock 0.1N iodine solution must be carefully prepared, standardized against the same strength of sodium thiosulphate, and the latter checked against a standard solution of potassium bichromate. The dilute iodine solution should be prepared in a 1 per cent solution of potassium iodide; since these solutions do not keep very long it is essential to prepare a fresh solution every day and to check against thiosulphate and potassium bichromate as above. For calculating the amount of glutathione per gram tissue present in a sample of extract, a typical example is shown.

Weight of 50 insects	13	grams
Weight of chitin (25%)	3.25	"
Water content (50%)	4.87	"
Actual weight of tissue	4.88	"
Trichloracetic acid used	45	cc.

5 cc. filtrate required 0.27 cc. 0.01 N iodine,

Hence 45 cc. filtrate required 9 x 0.27 = 2.43 cc. iodine.

Since 1 cc. 0.01N I_2 = 2.5 milligrams glutathione,

Hence 2.5 x 2.43 divided by 4.88 (wt. of tissue) = 1.24 mg. of glutathione per gram of tissue.

THE EFFECT OF ARSENICALS UPON THE GLUTATHIONE CONTENT. To determine the effect of arsenical dilutions upon the glutathione content it was necessary to feed or inject insects with a definite amount of neutral arsenic solution and after an interval of time determine the effect on the glutathione content. This was accomplished in the following manner. From 800 to 1,600 individuals of a species were separated into sexes, divided into lots of 50 for each sex, left without food for several hours, and weighed on a balance to four decimals. Usually four of the lots (2 lots of ♂'s and 2 lots of ♀'s) were used as controls and were injected with a 1/50 cc. of a 0.7 per cent saline solution. The remaining lots were injected with varying dilutions of arsenic acid or arsenious acid (0.00495 & 0.000495 grams per cc.), using 1/50 cc. for each insect. After injection, the insects were left for 3 to 5 hours for the solutions to become effective, and were afterwards ground with sand and trichloracetic acid as previously described, and samples drawn for titration with iodine.

In Table 1 the data obtained from 15,000 individuals belonging to 10 species were averaged and summarized to show the normal glutathione content for each species and the reduction in percentage due to arsenical treatment. It is readily observed from this table that the normal glutathione content and reduction due to arsenicals vary with the species. If we average the per cent reduction in glutathione for all the species we obtain the following figures. A reduction of 46 per cent due to 0.1N As_2O_3; a reduction of 36 per cent due to 0.01N As_2O_3; a reduction of 37 per cent due to 0.1N As_2O_5; a reduction of 28 per cent due to 0.01N As_2O_5. Or an average reduction of 41 and 32 per cent due to As_2O_3 and As_2O_5 respectively. (Fig. 37).

DISCUSSION. This preliminary study has shown considerable variation to exist in the normal glutathione content of insects. From the present state of the investigation it is impossible to definitely confirm or refute the possibility of a specific resistance towards arsenic to exist in some species. From Table 1 it is seen that *Malacosoma americana* Fab.,

usually considered resistant towards arsenic, contains a considerably lower amount of glutathione as compared with other species. That the variation might be due to factors, such as food and waste material in the alimentary tract, only imperfectly controlled is quite possible.

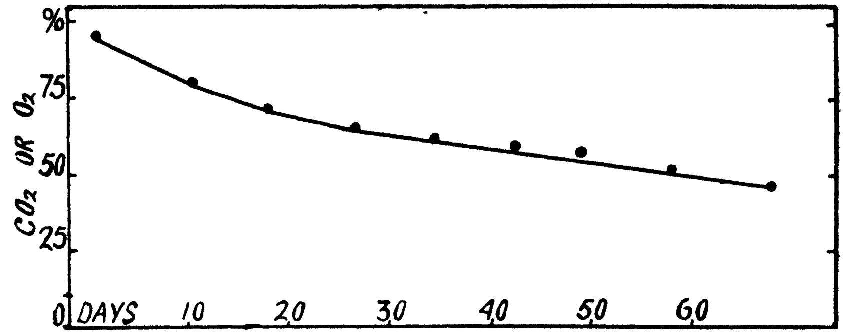

FIG. 37. The effect of arsenical dilutions on the glutathione content of insects.

The ideal method, to deal with separate organs and tissues, appears out of the question with insects.

There undoubtedly is also a quantitative difference in the method of disposal of the arsenic, which may be due to differences in rate of oxidation and excretion of the arsenic. Furthermore, whether arsenic reacts only with glutathione or perhaps also with other cell constituents remains to be determined. According to Voegtlin (7), arsenic may be considered as a specific poison for reduced glutathione, or the toxic action of arsenic may be due to an interference with the normal function-

THE GLUTATHIONE CONTENT

Species	Normal Content	Reduction After Treatment with Arsenicals			
		As_2O_3		As_2O_5	
		0.1N	0.01N	0.1N	0.01N
Leptinotarsa decemlineata	1.59 mg.	38%	28%	28%	28%
Do. Larvae	1.33 mg.	34%	37%	27%	25%
Popillia japonica	1.16 mg.	30%	24%	25%	17%
Do. Larvae	0.81 mg.	35%	28%	35%	27%
Tenebrio molitor (larvae)	1.1 mg.				
Pheletes agonous (larvae)	0.80 mg.				
Pieris rapae (larvae)	0.52 mg.				
Anasa tristis	0.45 mg.	64%	32%	49%	21%
Melanoplus differentialis	0.44 mg.				
Melanoplus femur-rubrum	0.30 mg.	30%	24%	23%	18%
Cotinis nitida	0.36 mg.				
Malacosoma americana (larvae)	0.18 mg.	81%	78%	77%	63%

ing of glutathione in oxidation reduction phenomena of tissues. The fact that glutathione is easily soluble in water makes it readily available for combination with arsenic, and the arsenic, through chemical affinity for the -SH group of reduced glutathione, inhibits the progress of oxidation and reduction in the cell.

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AN IMPROVED CARBON DISULFIDE EMULSION FOR THE CONTROL OF LARVAE OF THE JAPANESE BEETLE AND OTHER INSECTS[1]

By J. William Lipp, *Assistant Entomologist, United States Department of Agriculture*

Abstract

A carbon disulfide emulsion has been prepared in which rosin, C. P. sodium hydroxide and U. S. P. oleic acid are used to form the emulsifying agent. In this way variation in the composition of the emulsifying agent is cut to a minimum. At present this emulsion is the one recommended for the treatment of turf and of nursery stock for the control of Japanese beetle larvae. This emulsion has also given good results against the larvae of the Asiatic beetle, *Anomala orientalis* Waterh., and of the green June beetle, *Cotinus nitida*.

Introduction

During the last few years emulsified carbon disulfide has been used extensively for the control of the larva of the Japanese beetle. With the view of obtaining a formula which would be satisfactory from

[1]Contribution No. 31 from the Japanese Beetle Laboratory, Riverton, N. J. The author wishes to express his thanks to Mr. B. R. Leach for his suggestions and criticisms during the course of this work.

the standpoints of both toxicity to the larva and lack of injury to the vegetation involved in the treatment, many emulsions (*2, 4, 5*)[2] were prepared and tested.

Of these the most satisfactory, prior to the fall of 1925, was the one prepared by Leach and Johnson (*5*) having the formula:—Carbon disulfide 10 parts, water 3 parts and rosin fish-oil soap 1 part.

Unfortunately this emulsion stratified[3] very readily (Pl. 19,C), and thus necessitated agitation of the container in order to re-establish homogeneity of the contents. Since the emulsion is usually stored in 500 pound drums, the difficulty of agitating the container is obvious. Furthermore, the emulsifying power of the soap was uncertain on account of the variation in the composition of different batches of the commercial product.

LABORATORY WORK

With the above-mentioned material as a background, work was begun to prepare an emulsion which would have the desirable features of the old emulsion and be free of its disadvantages. This new emulsion should contain approximately the same percentage of carbon disulfide as the original emulsion in order to avoid the necessity of changing the dosages previously recommended. The emulsion should stratify as little as possible in order to eliminate the necessity of shaking the container to make the contents homogeneous. The emulsifying agent should be made from pure, standard materials, so as to cut to a minimum the variation in composition of the emulsifying agent and, consequently, the possibility of incomplete emulsification or breaking.[4]

In the preliminary experiments, solutions of sodium oleate (containing excess of alkali or acid) were used as emulsifying agents. These were made from U. S. P. oleic acid and C. P. sodium hydroxide (96–98% NaOH). As a result of these experiments an emulsion[5] containing 71% carbon disulfide was produced which, when allowed to stand in a glass cylinder, showed very little evidence of stratification. In addition, it appeared to dilute readily with water, but when the hands were

[2]Italic numbers in parentheses refer to References.

[3]The author has used the term "stratify" to indicate the formation of an upper aqueous layer. In this condition the carbon disulfide is still emulsified and can be diluted with water. By "break" is meant the formation of a lower layer of carbon disulfide, i. e., a separation of the emulsion into its component parts (Pl. 19, D). When this condition occurs, the mixture cannot be diluted with water.

[4]See footnote (3).

[5]The formula of this emulsion was: 472 cc. of carbon disulfide, 16 cc. of oleic acid and 173 cc. of N/5 alkali solution.

Fig. A. A sample of the new emulsion immediately after preparation.
Fig. B. A sample of the new emulsion after standing four months.
Fig. C. A sample of the rosin Fish-oil soap emulsion after standing four months.
Fig. D. An example of a broken emulsion with bottom layer of carbon disulfide.

immersed in this emulsion, diluted to the strength used under field conditions, a slight burning sensation was experienced. This seemed to indicate that the interface surrounding the minute carbon disulfide globule was capable of being ruptured rather readily, permitting the release of some of the emulsified material. It seemed unwise, therefore, to use this emulsion for field work on account of its probable destructive action on tender vegetation. Furthermore, this emulsion could be made only by mixing the oleic acid and the alkali and adding the carbon disulfide gradually to the soap solution and shaking after each addition. Not only was this undesirable from the commercial standpoint, but was likely to increase the cost of the final product on account of the additional labor involved.

Inasmuch as the soap used in Leach and Johnson's emulsion was partly a resinate, several mixtures of sodium oleate and resinate were prepared. The rosin and oleic acid in varying proportions were ground together in a mortar, and varying quantities of a 20% NaOH solution added and ground in. With these different soaps a series of emulsions was prepared, each emulsion containing 1 part soap, 2 parts water and 7 parts carbon disulfide. (70% carbon disulfide as compared with 71.4% in the old emulsion.) All these emulsions were very viscous. By dissolving the soaps in varying amounts of water several soap solutions were obtained which, when used in the ratio of 3 parts soap solution to 7 parts carbon disulfide, produced very satisfactory emulsions.

The formula chosen for the soap solution was:—50 grams rosin, 50 cc. oleic acid, 135 cc. 7% NaOH solution and 450 cc. water. On a large scale the equivalent of this formula[6] is:—9.5 pounds C. P. (96–98%) NaOH, 50 pounds lump rosin, 6 gallons U. S. P. oleic acid and 70 gallons water. (In factory practice it is customary to start with 10% more of each ingredient to allow for losses in handling.)

In preparing this soap solution the rosin should be pulverized and added gradually to the alkali solution (previously warmed). The water should now be added hot and the resulting mixture agitated until the rosin has dissolved. The oleic acid should be added next and the mixture again agitated. This soap solution should then be allowed to cool, but should be re-agitated before being used. If desired, this solution may be prepared in the cold, but much more time is necessary to effect the solution of the rosin in the alkali.

[6]An examination of this formula will show that the amount of sodium hydroxide used is not sufficient to form a neutral soap. This was done purposely, since the addition of too much alkali to the soil is undesirable, particularly in the case of the lawn grasses which require an acid soil for proper growth.

In the preparation of the emulsion 3 parts of soap solution and 7 parts of carbon disulfide should be agitated thoroughly until emulsification results. This point is reached when the contents of the container show a creamy white color (Pl. 19, A) and become quite viscous. A better test for emulsification is made by diluting a sample of the product with an equal volume of water. When diluted in this way the emulsion should show no signs of breaking, if properly made.

Control of Japanese Beetle Larvae

Field tests have shown that this emulsion compares favorably with the rosin fish-oil emulsion previously used. During the past two turf-treating seasons the new emulsion has been used and has given a satisfactory control of the Japanese beetle larvae without injury to the turf, except in places where the grass roots have been weakened by the feeding larvae prior to treatment. The present recommendations for the treatment of lawns and golf greens and of nursery stock (*6*) include the use of this emulsion.

Samples of this emulsion placed in tall cylinders showed no appreciable stratification except after long standing (Pl. 19, B). Under field conditions the container will necessarily be agitated every time a sample of the stock emulsion is used, so that a large stratification will never occur unless treatment is discontinued for a long period.

Low temperatures tend to cause this emulsion to become very viscous, and thus pouring and measuring, especially of small quantities, are rendered difficult. This disadvantage is encountered only in the case of early Spring and late Fall treating of nursery stock, since turf treating is carried on in the warmer weather.

The Control of Other Insects

At the Riverton Country Club and other clubs in the vicinity of Philadelphia this emulsion has been used successfully for the control of the larvae of the green June beetle, *Cotinus nitida*, and other white grubs. The habit of the June beetle larvae of making large entrance and exit holes in the turf, while very destructive and annoying, particularly on account of the mounds of soil thrown up, offers a very ready means of attack. If the holes are left open and the carbon disulfide emulsion is applied to the turf as recommended for the control of the Japanese beetle larvae, very satisfactory results can be obtained.

At New Haven, Conn., this emulsion has been used for the control of the larvae of the Asiatic beetle, *Anomala orientalis* Waterh, (*1*, *3*).

During the year 1926, nineteen tons of this emulsion were used in turf treatments for this pest.

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TWO SPECIES OF THRIPS[1] INJURIOUS TO APPLES IN THE PACIFIC NORTHWEST

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Abstract

So-called Pansy spot or thrips injury on apples is caused by the egg laying punctures of two species of thrips: *Frankliniella occidentalis* and *Aeolothrips fasciatus*. Injury of this character produced by thrips has been reported from most of the apple growing sections of the Pacific Northwest. In some instances the grade of the fruit has been lowered fully twenty per cent.

Pansy spot derives its name from the shape of a discolored area which develops about the egg punctures. The color of this pansy shaped spot varies from white through various shades of pink. Egg laying begins shortly after bloom time, continuing until the fruit has reached the size of large walnuts. The life history of the insect in the orchard is not fully known. Sprays of oil and Black leaf applied while the trees were in full bloom showed that injury can be materially reduced but do not give complete control. The Black Leaf appears to be the active ingredient in bringing about this benefit.

So called "Pansy Spot" or thrips injury on apples proved to be one of the outstanding insect injuries occurring in this fruit in several sections of the Pacific Northwest during 1926. This was particularly true in the Hood River Valley where the damage was general throughout the district. In former years, injury for the most part has been confined largely to orchards in the higher elevations. During the past season

[1] *Frankliniella occidentalis* and *Aeolothrips fasciatus*.

the insects were reported occurring in the Southern Oregon districts, Western Oregon, White Salmon (Wash.), Yakima, Wenatchee and to a lesser extent than usual in the Okanagan (B. C.) orchards. In the Hood River Valley it is estimated that this insect lowered the grade of fruit fully 20%.

Pansy Spot[2] is a term employed to describe the injury resulting from egg punctures of two species of thrips. The development of these spots and the extent of injury varies with the different variety of apple. These are particularly noticeable on such apples as the Northern Spy, MacIntosh, Transparent and, to a less extent, in other varieties grown in this section. From a very small russetted spot, or egg puncture develops a whitish or pinkish area closely resembling a small pansy in outline and color. The affected area is usually lighter colored than the ground color of the injured fruit and is therefore conspicious. Pansy Spots do not develop in all cases of puncturing, often a high percentage do not. The injury is very minute at the time of deposition. This rupture, however, expands with the growth of the apple forming russetted spots of variable size (Pl. 20, fig. 1).

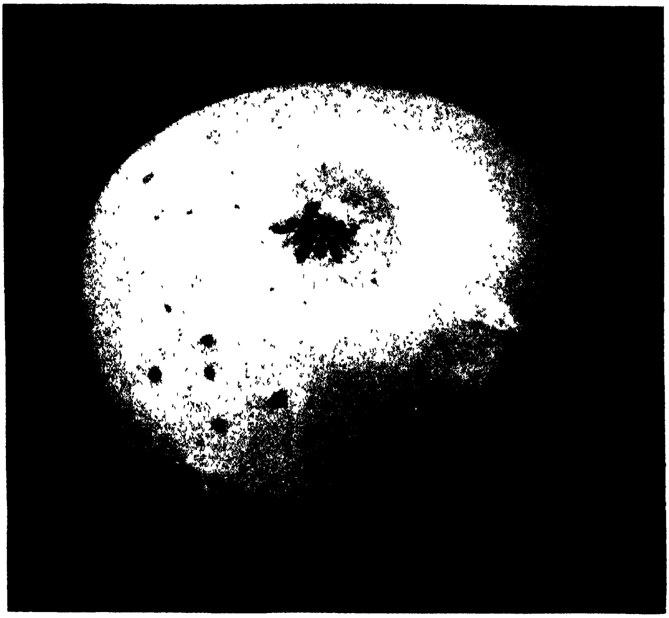
Where numerous, the grade of fruit is materially lowered. Often times the Pansy Spot shows on these varieties during the early part of the season, largely disappearing as the season advances. In such cases usually a small whitish area persists about the punctures or none at all. (Pl. 20, fig. 1.)

At least two species of thrips are involved. During the spring of 1924, two species were taken in the act of oviposition. Apples at the time were about the size of small walnuts. These were sent to Professor J. R. Watson, who writes as follows:

"The smaller, lighter colored thrips is *Frankliniella occidentalis*. The large black insect is *Aeolothrips fasciatus*. It is perhaps a distinct variety of the latter species as it differs in some respects from our eastern species. The most conspicuous difference is that the white area in the middle of the front wing does not extend clear across it but only makes a notch out of the wing. This is true of all three specimens you sent. I wish you would look over your specimens and see if this is true of all of them. If so it would merit our calling the insect a new variety.

Aeolothrips fasciatus is supposed to be predacious and my guess is that you will find this species is feeding on the other. However, this is only a suggestion for your attention and you can work it out on the

[2]Venables, E. P. Proc. Ent. Soc. B. C., No. 22, 1925.



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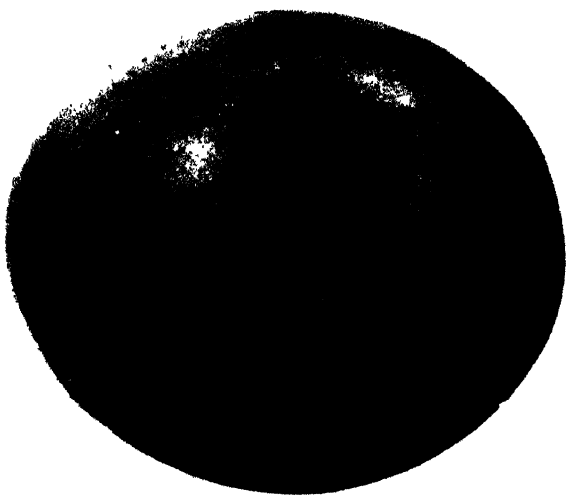


1 Pansy spots and russet spots on Newtown developing from egg punctures of thrips (Original)
2 Russet developing on Newtown as result of spraying in full bloom and calyx with Dormoil 3–100 (Original)

grounds. I shall be glad to hear further what you can find out about the relation of the two."

The life history and habits so far as their occurrence in the apple orchards of the West are little known. Venables[2] reports finding eggs of thrips in considerable numbers in the flower parts at and shortly after blossom time. Both species have been observed in the flowers at this time in the Hood River district. Egg laying doubtless begins during this period though this has not been actually noted, the first observations being made a short time after the flower parts had dropped. Egg laying continues until the fruit reaches an inch or an inch and half in diameter. Shortly after the fruit reaches this size thrips are found on the trees with difficulty. During May, 1925, the larger of the two species—*Aeolothrips fasciatus*, was found depositing eggs in the midribs of apples leaves, this deposition appeared to be more extensive than in the fruit itself. During the spring, larval thrips can be found on the foliage, their presence, however, does not seem to be associated with injury to the plant. The larva of *A. fasciatus* seem to be more numerous than *F. occidentalis*. The former is probably a predacious species while the latter probably drops to cover crops or weeds to complete its growth.

TABLE 1. THRIPS CONTROL ON APPLES, 1924–1925, HOOD RIVER, OREGON

Exp. No.	Spray Date	Material Used	Apples Counted	Egg Punctures on Apples 3 or more	Egg Punctures on Apples Less than 3	Total	% Injured	% Spray Injury
1924	May 10	Oil[1] 3–100						
B-2	(full bloom)	Bl. 40 1 pt–100						
			1003	53	194	247	24.6	13.2
	May 15	Same plus						
	(calyx)	Ars. L. 2–100						
B-2a.	May 15	Oil 3–100						
	(calyx	Bl. 40 1 pt–100	1063	127	328	455	42.8	9.2
	only)	Ars. L. 2–100						
Check		No spray	1095	227	415	642	58.6	0
1925	May 5	Oil[2] 3–100						
B-1	May 16	Oil[2] 3–100	1021	54	230	284	27.8	0
		Ars. L. 2–100						
B-2	May 5	Oil 3–100						
	(full bloom)	Bl. 40 1 pt–100						
	May 16	Oil 3–100	1000	12	133	145	14.5	0
		Bl. 40 1 pt–100						
		Ars. L. 2–100						
Check	No spray	No spray	1009	32	292	324	32.1	0

[1]Dormoil, Hood River Spray Company, used in tests of 1924.

[2]Triona, Balfour Guthrie Company, used in tests of 1925.

Venables reports leguminous crops favorable to the development of *F. occidentalis* where in parts of British Columbia it seriously affects alfalfa seed production. Cover crops, their choice and management, may prove to be a factor in controlling the pest.

During 1924 and 1925 some spraying tests were applied to determine effects on control. In 1924 two tests were applied to determine whether a spray applied in full bloom and shortly thereafter would be of benefit in reducing the injury to fruit. Experiment B-2 (Table 1) consisted of Dormoil 3–100, Black Leaf 40, 1 pint to 100 gallons. The trees were sprayed in full bloom. This formula was repeated as soon as the petals fell. A block of trees (Exp. B 2a) not sprayed in full bloom was sprayed in the calyx with this formula. Some injury to the petals was noted in B-2, many of these turned brown shortly after the spray was applied. A good crop of fruit set, however. The results obtained in these tests are tabulated in Table 1.

Though control was not obtained the results proved that egg laying was noticeably reduced. The full bloom and calyx application reduced the injury more than 50% although 24.6 of the apples showed some injury where the two applications were made. 42.8% injury developed where the calyx spray only was applied, 58.6% in the unsprayed checks. The oil used in these tests was of the dormant type and the fruit showed the effect of the spray at harvest time. (Pl. 20, fig. 2).

The work was continued in 1925, Triona oil being substituted for the Dormoil. The oil was used alone and in combination with Black Leaf 40 (Exp. B-1 and B-2, 1925). A third test in which Black Leaf 40 alone was applied. This experiment was overlooked at the time the results were tabulated and the data relative to its effectiveness were lost. Observations made during the summer indicated the results to be about as found in B-2, 1925.

Infestation was much less severe in 1925. The unsprayed trees developed 32.1% affected fruit, of which but 3% showed more than three egg scars. In 1924 approximately 20% of this type of injury occurred. As in 1924 injury was reduced approximately 50% where the full bloom and calyx spray were applied with oil and Black Leaf 40. The oil alone was not effective.

Thorough discing or plowing before blooming is recommended as a possible aid in the destruction of overwintering insects. Even though present known sprays are only partially effective, applications would be advisable under such conditions of infestation as prevailed in the Hood River Valley during 1926.

A EUROPEAN NITIDULID, *BRACHYPTEROLUS PULICARIUS* L. (COLEOPTERA, FAMILY NITIDULIDAE).

By G. E. R. Hervey

ABSTRACT

This small black nitidulid beetle was probably introduced into this country from Europe quite recently. The adults feed in the blossoms of a variety of plants, including strawberry. It seems doubtful that they cause any injury to the latter. They breed only in *Linaria vulgaris*. As far as is known there is only one generation a year.

During the latter part of May 1924 a small black beetle was observed on strawberry plants in Dutchess County, N. Y. This insect was sent to the Department of Entomology at Cornell for identification and it proved to be *Brachypterolus pulicarius* Linn., a recently introduced nitidulid. The following observations were made the summer of 1925. The object of the study being to determine whether the feeding of this insect in strawberry blossoms caused any injury.

This insect was first described by Linnaeus in 1758 in the tenth edition of his "Systema Natura." He called it *Dermestis pulicarius* and stated that it was found in flowers. Later, in 1788, in the thirteenth edition of the above work he changed the generic name to Silpha. Apparently the species is rather widely distributed in Europe and it has been called a rather large array of names by various European writers. A complete list of the synonomy is given by Grouvelle, 1913.

In America the species was first mentioned about 1919. At this time specimens were sent to the United States National Museum from Youngstown, N. Y., for identification. In 1920 Notman described what Schwarz considers as this species under the name of *Heterostomus mordelloides* from Schoharie County, N. Y. Britton states that in 1921 specimens were collected on the grounds of the Arnold Aboretum near Boston. In the same year a single specimen was taken at Milford, Connecticut. In 1922 Dr. Felt reported this insect from the following Counties in New York State: Columbia, Saratoga, Albany, Niagara and Schoharie. Since 1924 the writer has collected and received specimens from Dutchess, Greene, Genesee, and Tompkins Counties in New York State. Apparently the species is more common in the Hudson River Valley than in any other part of the state.

The most common food plants of this beetle in Europe appear to be *Linaria vulgaris*, common toad flax or butter and eggs, and other species of this genus. The following food plants have been listed by different European writers: *Linaria vulgaris*, *L. supina*, *L. striata*, *Galium mollugo* and *Spiraea ulmaria*. In America Hatch reports in the

Cranberry Lake Coleoptera that the adults were collected in large numbers on dandelions The adults have been observed by the writer on the blossoms of strawberry, dandelion, wild mustard, clover, apple, panicled dogwood, and toad flax. As far as is known the insect only breeds in *Linaria vulgaris* and this also seems to be, by far, the favorite food plant of the adult.

In 1922 Dr. Felt called attention to this insect in the insect pest survey bulletin and stated that it has been injurious to recently opened strawberry blossoms in Southern Columbia County, N. Y. He stated further that the injury was due to the adults feeding on the developing anthers and adjacent tissue causing "nubbins" and blasted blossoms.

Blasted blossoms and nubbins are due to a variety of causes and it might be well to enumerate some of them here. Prof. Oskamp of the Department of Pomology at Cornell states that blasted blossoms and nubbins are largely due to frosts and imperfect fertilization. According to Chandler in his book on fruit growing "if a considerable number of the pistils are sterile an irregular shaped berry will be produced, such as may be produced as a result of injury to the berry from insect punctures." Fletcher in his book on strawberry growing gives the following cause of nubbins: imperfect pollination, injury to the pistils, winter injury, and the work of weevils and other insects. Nubbins are more abundant late in the ripening season when the pollen supply is likely to be short and the plants somewhat exhausted. In another chapter the same writer discusses "buttoning" which is apparently another form of malformed berry. The causes of this trouble are frost, punctures of the tarnished plant bug, dry weather and insufficient nourishment. He states that frost injury is confined to the pistils which turn black when affected. A light frost merely touches the apex of the cone of pistils causing the berry to button.

Observations made the summer of 1925 show that the beetles feed in the strawberry blossom during the whole period of blooming which lasts approximately a month. However, during the latter part of this period their numbers on this plant are relatively much fewer because many of them have migrated to the blossoms of other plants. Numerous blossoms in which the beetles had been feeding were examined and it was found that small areas had been eaten out of the base of the stamens. In most cases it was slight enough to be hardly noticeable. Whether this injury is sufficient to affect the berry has not been definitely established but it seems doubtful that it would be. From the literature examined it seems that malformed berries are due to injury to the pistils

by frost or some other agency. In the case of the blossoms examined none showed any injury to these parts. Blasted blossoms in 1925 were very common in practically every planting, even where the beetles were not present, but it is thought that this was due to frosts during the period of blooming.

A relatively small amount of information on the life history of this species was gained from the literature. Cornelius, in Germany in 1863, made some observations and worked out the life history in some detail. He also gave a description of the larva and pupa. Kaltenbach, in 1874, observed the larvae feeding first upon the pollen and later upon the seed capsule of toad flax. He stated that they transform in the soil around the plant and emerge as adults in September.

In 1925 the adults were first observed on May 6th. They were quite numerous at this time in several strawberry plantings in Dutchess County. Observations made up to May 15th showed them to be confined entirely to this plant. After this date they were found in the blossoms of a variety of plants, such as dandelion, wild mustard, panicled dogwood and the terminal shoots of *L. vulgaris*. The beetles were mating on June 27th. At this time they were feeding entirely on *L. vulgaris* which was just beginning to come into bloom. The first eggs were found on July 20th. They are laid in the unopened bud of *L. vulgaris* and just under the corolla. Usually only one egg is laid in a bud but in some cases as many as three are found. Larvae were found on July 23rd. Apparently some of them had been hatched for several days because they were quite numerous and some were partly grown. The larvae feed upon the ovary of the blossom and in many cases they will be found with the head and part of the body within the ovary. Usually only one larvae is found in a blossom but occasionally two. In a few cases larvae were found feeding within the seed capsule but these were comparatively rare. On August 6th the larvae were very numerous and in all stages of growth from recently hatched to full grown. The first pupa was found on August 7th. They are buried about two inches in the soil and are very active and wriggle around when disturbed. Both larvae and pupae were present all through August and until September 21st when the last observation was made. During September adults, presumably, of the new generation were very numerous in the blossoms.

ADULT: Form oval, strongly convex and sparsely clothed with brownish hairs. Color black and partly shining above; legs and antennae rufous; first segment of antenna darker than remainder; posterior legs usually somewhat darker than the others. Dorsal surface of body deeply and thickly punctate; punctures on head and dorsal surface of abdominal segments somewhat finer. Posterior half of sides of

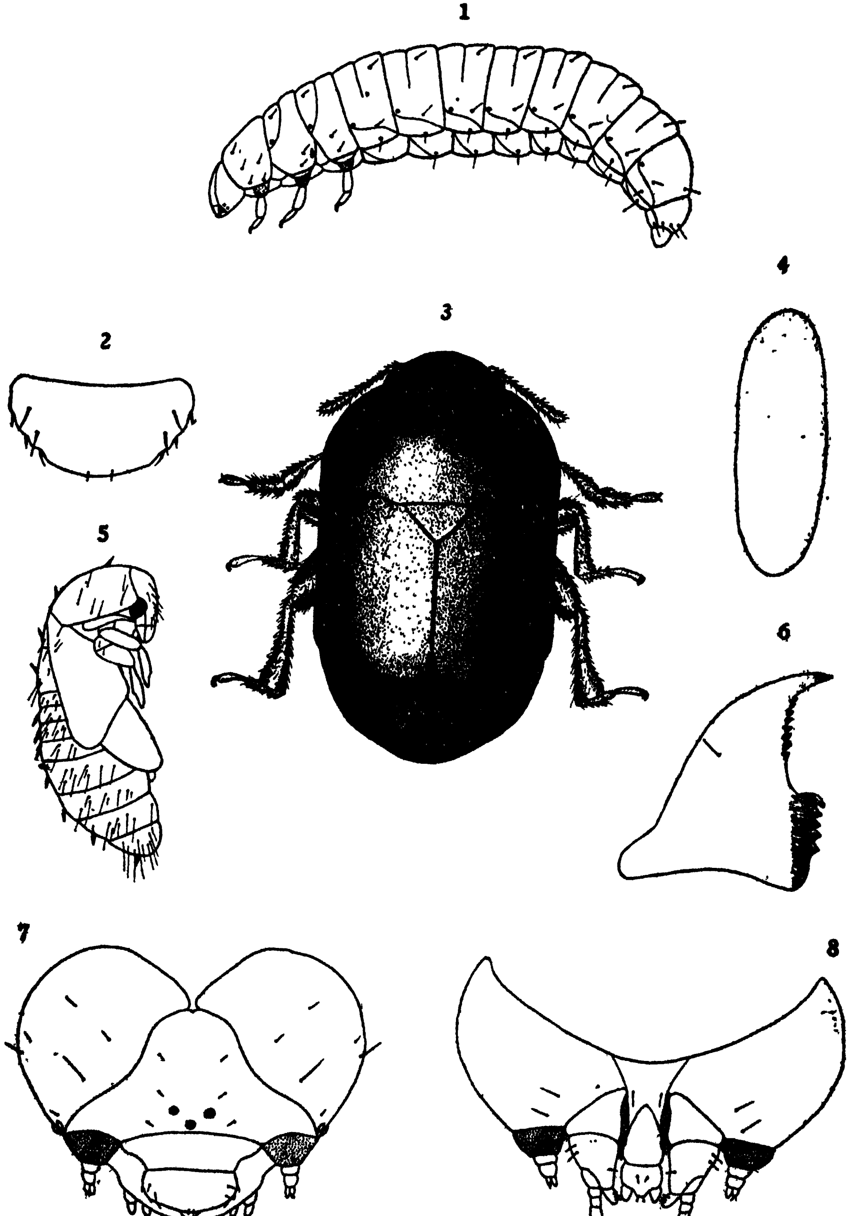


Fig. 38. *Brachypterolus pulicarius* L. 1. Larva, 2. Labrum of larva, 3. Adult, 4. Egg, 5. Pupa, 6. Mandible of larva, 7. Dorsal aspect of head of larva, 8. Ventral aspect of head of larva.

scutellum smooth shining and impunctate. Head about half as wide as thorax. Antenna sub-capitate; club elongate; joints one and two subequal, globular; three elongate and subequal to four and five. Thorax convex, about two-thirds wider than long; sides parallel at base, strongly arcuate towards apex; apex strongly emarginate, angles acute; posterior angles rectangular; base trisinuate. Elytra one-third longer than thorax; apices rounded and separated. Two abdominal segments exposed dorsally, female; three, male. Abdominal segments two and three, ventrally, very short, not equal to fourth; fourth longest. Middle and posterior legs flattened; tibiae dilated at tip and crowned with a row of equal spines; outer margin of tibiae of anterior and middle legs with a row of spinules. Length 2.2–2.6 mm. Width 1.0–1.2 mm.

EGGS: The egg is about three fifths of a mm. long. Color white when first laid but yellow just before hatching.

LARVAE: The full grown larva is about 5.5 mm. long, strongly convex above and flattened below. Mandibles, head, and thorax brownish with light median stripe on prothorax; remainder of body pale yellow. Ten abdominal segments; tenth much reduced. Head heart-shaped, somewhat broader than long. Epicranial sutures distinct and extending from median line of caudal margin of head to antennal ring in front of simple eyes. Frons sub-triangular and bearing three depressions in the form of a triangle near the cephalic margin; also provided with three pairs of setae. Frons and clypeus not distinctly divided. Labrum about twice as wide as long; anterior margin somewhat crenate and rounded; margin provided with four small setae on each side; two other more prominent setae placed back from the margin. Epicrania large and rounded posteriorly; each lateral half bears eight setae, six dorsally and two ventrally. Simple eyes represented by two small lens-shaped spots situated behind the base of the antenna; some specimens show a trace of another pair of simple eyes situated caudad of the first pair. Antenna with three segments; basal membrane large and does not show any evidence of chitinization; first segment much broader than long, second about as broad as long, third consists of two parts, one lying above the other; dorsal piece of terminal segment rounded at tip and bears a small seta and tubercle, ventral piece slightly longer and conical. Mandible dark brown and sickle shaped; pointed apically and provided with eight acute teeth near apex; molar part bears two rows of five teeth each; first pair large and directed backward, others decrease in size posteriorly. Maxilla consists of cardo, stipes, palpifer, palpus and mala. Cardo somewhat membranous, large and triangular. Stipes chitinized and provided with three setae, two on outer margin and one on the inner. Palpus three-segmented, first two segments about equaling the third in length. Mala provided with three setae on inner margin. Labium consists of submentum, mentum, ligula and palpus. Submentum membranous and not distinctly separated from gula. Mentum chitinized and provided with two small setae. Ligula small and not separated from mentum; provided with two setae at tip. Palpus one-segmented and projecting forward slightly further than ligula. Prothorax undivided dorsally; provided with five setae on each side. Meso and metathoracic segments divided dorsally into prescutum, scuto-scutellum and pre-epipleurum; alar area not marked; they are provided with setae as follows: one on prescutum, one on scuto-scutellum and one on alar area. Each typical abdominal segment divided into prescutum, scuto-scutellum, epipleurum and hypopleurum; provided with setae as follows: one on scuto-scutellum, one on alar area, one on eqipleurum and one on hypopleurum.

Spiracles are present on the mesothoracic segment and on the first eight abdominal segments.

PUPA: The pupa is about 2.8 mm. long and 2.0 mm. wide. Color yellow. Body rather sparsely covered with long brownish hairs, expecially head and last abdominal segment. Legs and wing pads closely appressed to the body. Tarsi distinct but do not show segmentation. Head drawn into thorax to eyes; mouthparts pressed close to body; labrum and mandibles distinct, latter chitinized. Antenna club-shaped but not segmented. The dorsal surface of thoracic segments provided with four pairs of spines which project towards head. Each abdominal segment provided with a pair of spines which project caudad.

A STUDY OF THE BIOLOGY OF THE PARSLEY STALK-WEEVIL *LISTRONOTUS LATIUSCULUS* BOHEMAN COLEOPTERA: CURCULIONIDAE

By ALFRED M. BOYCE, *Cornell University*

ABSTRACT

An infestation of the Parsley stalk weevil, *Listronotus latiusculus*, exists in the progressive market garden section of Long Island near New York City and appears to be a serious menace to carrot growing there. The results of one season's study (1926) are reported, including observations on life history and habits, food plants, distribution and a note on possible control.

For the past few years the market gardeners in the vicinity of Valley Stream, Long Island have experienced losses due to the depredations of a comparatively new pest of the carrot crop, namely *Listronotus latiusculus*. The writer had the opportunity to make a study of this pest during the growing season of 1926.

HISTORICAL

L. latiusculus was first described from Pennsylvania by Boheman in 1842. The species was taken originally from the Arrow weed plant, *Sagittaria variabilis* and received the common name of the Sagittaria curculio. In 1902 when the fact was established that this species had migrated to the parsley plant as a host and that most of its eggs were deposited in the stalks, the name of parsley stalk weevil was appropriately given to it. More recently when it was known to attack carrots it has been referred to in literature as the carrot weevil.

Blatchley and Leng in describing the Genus Listronotus, reported that all the species whose habits are known breed in semi-aquatic plants. Since *Sagittaria variabilis*, the original host of *latiusculus*, grows in a semi-aquatic environment, we must naturally assume that this species has changed its habitat to dry land plants. Furthermore, as will be

pointed out later, it has apparently changed its oviposition habits with its change of host.

In this study adults reared from larvae taken from roots of the present known host plants were identified by Dr. E. A. Chapin of the U. S. Bureau of Entomology and by Dr. Charles Schaffer of the Brooklyn Museum as *L. latiusculus*.

Distribution

According to Blatchley and Leng the general distribution of the weevil is as follows, "The type, is from Penn. Ranges from Quebec, New England and Michigan, west and south to Colorado, Kansas and Georgia."

The first record of its economic importance was in 1902 when it was reported as causing serious injury to parsley grown at Four Mile Run, Va. The growers there had first noticed its presence in 1900. In 1915 it was reported for the first time from Connecticut, causing injury to parsley growing in cold frames near New Haven. In 1916 parsley grown in the experimental garden attached to the Department of Agriculture at Washington, D. C., was noted to be injured by this species. In 1922 it was reported as injuring carrots in a backyard garden at Washington, D. C., and in 1923 as being a serious pest of carrots in the vicinity of Valley Stream and Astoria, L. I., N. Y., and in a portion of southwestern Illinois.

Food Plants

In this study adults were reared from larvae taken from the roots of carrot, wild carrot (*Daucus carota* L.), curled-leaved parsley, hymicha (Hamburg parsley, *Apium petroselinum* L.), and dill (*Anethum graveolens* L.), all of these being members of the Umbelliferae family. An attempt was made to determine which of these host plants was preferred by the insect but no conclusions could be drawn as there was a lack of evidence to show a distinct liking of one host over another. On inspecting wild carrot plants growing naturally along roadsides, in vacant lots and elsewhere it was found that the larger percentage of them were infested with larvae of what proved to be, when reared, *L. latiusculus*. Such a condition was found to be general on Long Island, wherever the wild carrot grows naturally. This fact may be of great importance in certain situations for such a condition might well afford a potential source of infestation.

Injury and Losses

On Long Island it is the early crop of carrots that is attacked and losses involving as much as 75% of the crop are reported by growers.

This injury in some cases has been great enough to discourage the growing of the early crop. The later crop is practically free from injury.

The greatest damage is done by the larvae. Their feeding in the roots results in injury which affects the sale of the carrots. In the case of parlsey (curley-leaved variety) the stalks and leaves are the salable parts and injury to the roots of this plant when severe, result in the yellowish sickly condition of the leaves, which renders them unsalable. With hymicha the major injury is to the roots which greatly reduces their market value. With all the hosts of this species some stunting was noted, the degree of which depends primarily upon the size of the plant when the larvae begin feeding in the roots and the number of larvae present.

Description

The Egg. The eggs are ovoid and somewhat elongated, measuring about .75 mm. in length by about .50 mm. in width. They are light colored when first deposited but soon acquire a dirty brownish or dusky color.

The Larva. The larva when full grown measures from 6 to 8 mm. in length and is only slightly curved in form. It is a legless grub, creamy white in color except for the head which is amber colored or reddish brown, the mouthparts being much darker. Each segment of the body bears a series of setae, while the first three anterior ventral lobes have a group of setae on each. There are a few scattered setae on the head.

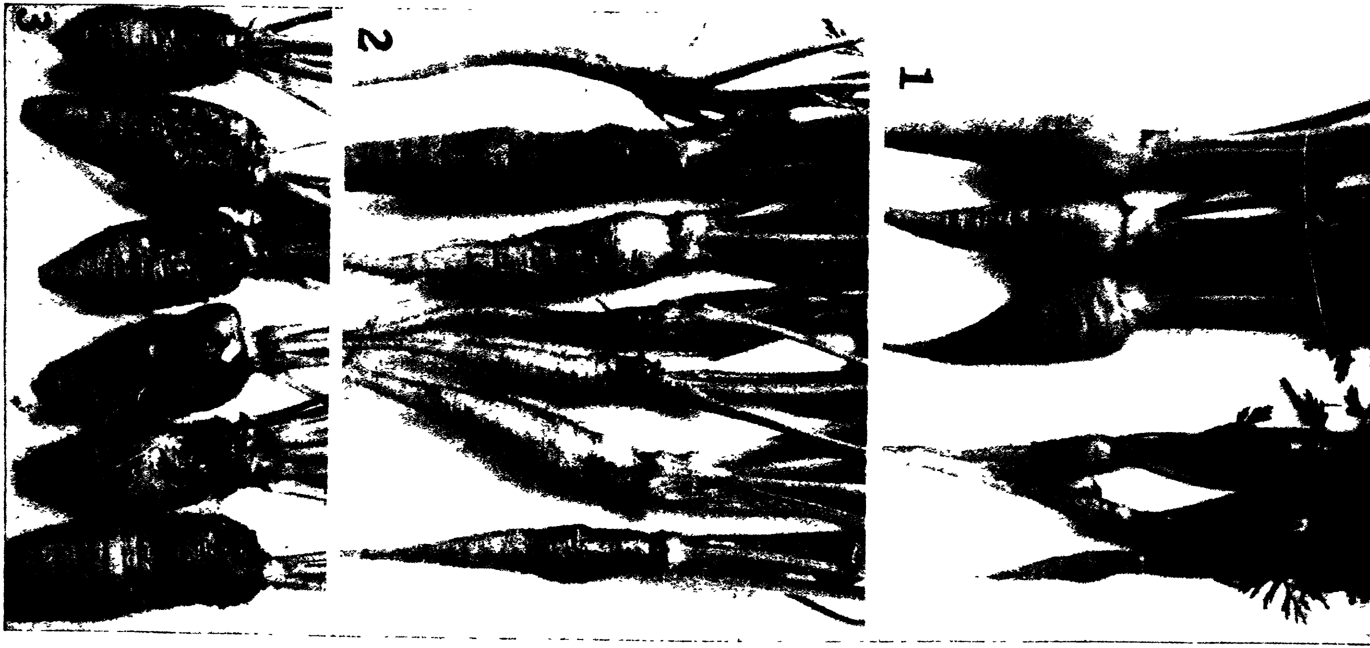
The Pupa. The pupa is of the exarate type, measuring from 6 to 7 mm. in length, and is creamy white in color. It is well provided with stiff brownish spines, there being a transverse row on each abdominal segment, the head, thorax and femora of the legs bearing them in definite positions also.

The Adult. The adults are from 5 to 6 mm. in length, the males being decidedly smaller than the females. The ground color of the body is very dark, nearly black, and the thorax and elytra are heavily armored with dull grayish and cupreous tinged scales, those on the thorax being slightly larger than those on the elytra. The grayish scales form three faint stripes on the thorax and a slight mottling on the sides of the elytra. Each stria of the elytra bears a row of short grayish setae and the venter of the thorax and abdomen is clothed with numerous short setae. The head has scattered scales and more short cupreous setae with rather a definite arrangement. The beak is slender with three feeble carinae dorsally. The antennae and tarsi are deep amber coloied or reddish brown, and the femora and tibiae of the legs have scattered scales and numerous short setae.

Life History and Habits

Three generations were reared on Long Island, with considerable overlapping of the broods. There was apparently continuous breeding thruout the season.

The Eggs. The first deposition of eggs was noted on May 21, when the carrot plants were about three inches high. They are deposited in



Parsley stalk weevil—1. Infested and uninfested carrots of the same age from the same bed. 2 Young carrots infested. 3. Injured carrots at harvest.

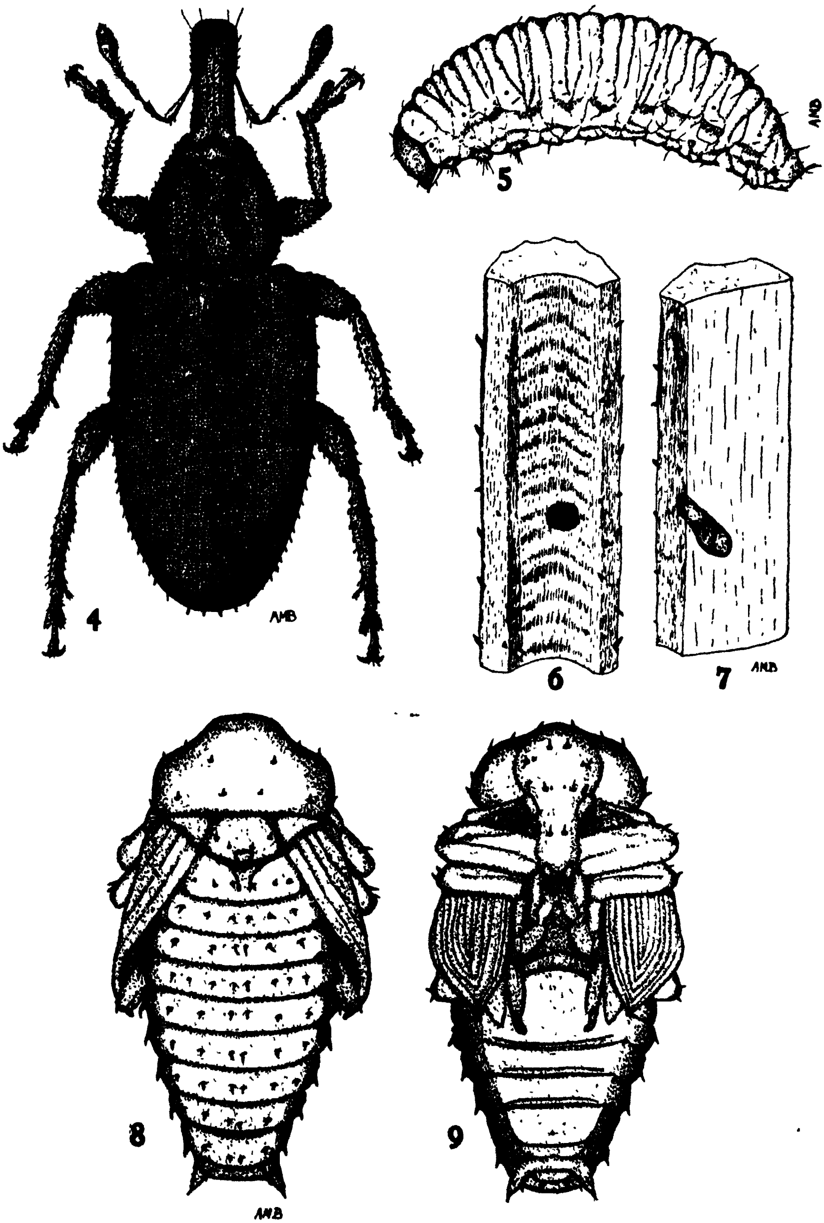


FIG. 39.—Parsley stalk weevil.—4. adult. 5. Full grown larva. 6. Egg-cavity in carrot leaf stock. 7. Section of same. 8. Pupa, dorsal view. 9. Pupa, ventral view.

cavities which are hollowed out in the stalks by the female. There are usually three or four eggs in each cavity with occasionally more, some cavities having as high as seven or eight. The cavities are sealed immediately after the eggs are placed in them, with a black exudate from the caudal end of the body, probably a secretion from the alimentary canal. As many as eight egg-pockets were found on a single plant and from counts made of the position of the cavities it was shown that fully 80% of the pockets are on the inside or concave face of the stalk. Early in the season, before cultivation of the crop was begun, the crowns of the young plants were exposed and the females freely oviposited in them.

The eggs of the first generation hatched in from 10 to 14 days with an average length of about 12 days for the incubation period. The eggs of the later generations hatched in from 7 to 10 days, the average period being about 8 days.

THE LARVA. The young larva on emerging from the egg is very active and begins feeding on the interior of the stalk, making a tunnel which in most cases extends downward toward the base. When the egg-cavity is made within one or two inches above the base of the stalk the larvae usually tunnel downward and enter the carrot at one side of the crown. But when the larva is hatched in an egg-cavity relatively high up on the stalk it usually tunnels for an inch or two upward or downward, makes an exit hole and either crawls down the outside of the stem or drops to the ground to enter the carrot from the soil.

The first indication of the presence of a larva in the carrot is its tiny entrance hole, which is rusty in color. It was not uncommon to find carrots containing larvae which entered the root as deep as one inch below the surface of the soil. In some instances nearly full grown larvae were found in the heart of the bases of the stalks, having not yet entered the root, tho having chewed off the bases of most of the stems. When the larvae have entered the carrot they tunnel in a more or less zig-zag direction, confining their feeding to the upper half of the root and in the outer fourth, seldom attacking the heart. The epidermis over the tunnels becomes dark brown and dies exposing the bare tunnels with their damp sticky frass. There are usually several larvae in a carrot and their tunnels may run together resulting in a broad lesion.

The larval stage lasts about fourteen days. When mature, the larva ceases feeding, leaves the carrot and enters the soil to a distance as far as two inches from its exit, where it constructs an earthen cell and pupates. In constructing this cell it bends its body back and forth

very rapidly thereby pushing the soil from around it and firmly packing it at the same time. This usually requires about 10 to 12 hours, and then the larva quiets down and transforms to a pupa within 1 to 5 days. This appears to be a definite prepupal stage and varies considerably in length with the different individuals. In rearing cages the first larvae to pupate did so on June 30th.

THE PUPA. The pupae remain inactive in their earthen cells thruout the pupal period unless disturbed. If the cell is destroyed they attempt to build another by wriggling their abdomen back and forth, a characteristic habit of the larvae. Records show that the pupal period lasts from 6 to 12 days, with an average of about eight days.

THE ADULT. The first adult emerged in the rearing cages on July 8. After transformation to the adult stage the weevils remain in the pupal cell for one or two days and then migrate to the surface of the soil. They are of chestnut brownish color at this time and are easily recognized as having recently emerged from the soil.

The adults that deposited the eggs for the first generation were first observed on May 21, presumably having then recently emerged from hibernation. Copulation takes place in the spring before the eggs are laid. The males were observed to remain clinging to the females for a period of several days. The beetles feign death when disturbed and remain motionless for a short while thereafter. They feed by shaving off the epidermis of the stalk with their mandibles or they may chew in the tissue in one spot until a cavity is formed. This practice is most characteristic during oviposition and into such cavities the eggs are placed and the opening sealed with a blackish material. It is interesting to compare these egg-laying habits with those described for this species by Dr. C. M. Weed from Ohio in 1889. Dr. Weed says, "*L. latiusculus* breeds in the stalks and seed heads of the broad leaved arrowhead, *S. latifolia* Willd., the eggs being laid in bunches of five to ten on the leaf stalk, and covered with bits of epidermis chewed up by the mother beetle."

The beetles have never been observed in flight altho they have fully developed wings. An examination of their wings furnishes some evidence that they do not fly except under the most favorable conditions, as the wings appear to be inadequate to efficiently support in flight a body of such size. A study of the infestations also indicates that they do not fly actively, since they were found only in carrots planted on soil that was infested the previous year.

How and where the insect hibernates has not yet been definitely established but there are indications that it passes the winter in the adult stage in the area where its food plant was grown that season. Some evidence to support this is derived from the fact that adults were taken early in the winter from debris about one inch below the surface of the soil in a field on which infested carrots had been grown. The common practice among the truck growers is to apply a heavy application of manure on the soil after the last crop is harvested and then turn this under to a depth of five or seven inches. In the spring plowing and harrowing much of the soil that was turned under in the fall is again brought to the surface. Such a practice may furnish excellent conditions for the hibernation of the weevils.

Seasonal History

First generation larvae began to hatch out on June 2, and the first adults appeared on June 25. The peak of emergence of this generation was estimated to have been about July 22.

Females of the first generation began to oviposition July 17 and adults began to emerge on August 16, the peak being reached about September 15.

For the third generation oviposition began on September 6 and the first adults appeared October 9.

The injury is caused by larvae of the first and second generations and it is very likely that a full second and a third generation do not develop under existing conditions, since practically all the early crop of carrots is harvested by August 15 at the latest. In no instance have the beetles been observed to feed on or breed in any of the vegetable crops following carrots. If the weevils are capable of flight it seems reasonable to assume that they would migrate to nearby or adjoining plots of the late crop of carrots. Such a migration was not observed.

Methods of Control

Rotation of the carrot crop appears to be entirely effective in controlling this pest. However, in rotation, other members of the Umbelliferae family should not be used as the weevil has been found to attack them. The effectiveness of rotation in elminating this pest has been fairly well demonstrated in several cases. A typical one being the case of a grower who planted his main carrot crop on a plot just across a roadway from an area that was heavily infested in previous years. He also planted one bed in the previously infested area to carrots again

and in this bed there developed a 70% infestation, while in his main crop no infestation was in evidence.

Some experiments were made on a small scale with arsenate of lead spray, sodium fluosilicate dust and carbon bisulphide emulsion but the data obtained was of little value.

It is possible that late thinning would be effective to some degree in that many plants containing egg-cavities and the earlier of the first generation larvae would be pulled up and these stages would not have a chance to develop.

QUANTITATIVE METHODS OF COLLECTING AND REARING SOIL CUTWORMS[1]

By KENNETH M. KING and N. J. ATKINSON, *Saskatoon, Saskatchewan*

ABSTRACT

In this paper are described in considerable detail the methods of collecting and rearing soil-infesting cutworms which several years experience has shown to be the most suitable and efficient, under Saskatchewan conditions, for securing accurate estimates of the relative (and to some extent the actual) abundance of the cutworm species involved, and the abundance and effectiveness of their various insect parasites and diseases. An attempt is made to distinguish between those methods which are essential under nearly all circumstances, and those which, though non-essential, should be employed when conditions permit. A few instances are cited illustrating the working out of these methods in actual practice.

Three general conclusions are drawn. 1. Each cutworm must be kept isolated from the moment of collection and be reared with such precautions as will minimize the subsequent effects of the changes or conditions or the possibilities of cross-infection. The employment of this technique, more than any other point in the procedure, conditions the entire results. 2. The methods of collecting must be so systematized as to make each collection truly representative of its immediate location. 3. More valuable returns are secured, for the efforts expended, by making several successive or otherwise comparative small collections rather than a few large ones.

The place which the collecting and rearing of immature stages holds in connection with insect field work is well recognized. In studies of economic soil-infesting cutworms the rearing of larvae collected from natural conditions is usually the only satisfactory method of estimating the relative abundance and effectiveness of the various insect parasites and protozoan, bacterial or fungous diseases occurring. It is frequently also the only accurate means of determining the various host species concerned and their proportional numbers.

Several years experience in this work have convinced the writers that, in Saskatchewan at least, dependable or comparable results in the

[1]Contribution from the Division of Field Crop and Garden Insects, Entomological Branch. Dept. of Agric. Ottawa.

above respects can seldom be attained except by systematized methods of collecting and by careful individual rearing of larvae.[2]

The data obtained in any such work should, of course, reflect as accurately as possible, considering time and labour limitations, the conditions as they existed in the area under study. The writers find that, even in relatively superficial observations, the employment of the methods outlined below gives greater efficiency of labour than does the somewhat haphazard collecting and massed rearing of larvae often used. The methods described in this discussion are those which have proved most effective under Saskatchewan conditions. The principles brought out, however, appear to be equally applicable not only to other regions but also to groups of insects other than soil cutworms.

Selection of "Fields" for Collections

Throughout the present paper, the word field is used in a somewhat restricted sense as the most appropriate term to designate an area, varying in size from ¼ acre to 100 acres or more, but relatively uniform with respect to the more important conditions affecting cutworm distribution and abundance. Thus the limits of the field, in the sense used here, usually coincide with the boundaries of the enclosed area (or field in the usual sense), but may not always do so. The keyword is "relatively" uniform,—that is, the decision in any instance must be based on the judgment and experience of the observer.

The factors which have proved worthy of consideration, as affecting the rate of infestation and the cutworm species involved, include the topography, the soil and its state of cultivation, the vegetation, and the known or probable proximity of moth food at the time of major flight of the various species during the preceding year. The potential importance of these factors is well illustrated by the pale western cutworm,[3] the abundance of which in different fields in a district in which it is endemic in a given year has been found to bear a very close relation to the amount of surface disturbance during the preceding August and early September. The type of soil, as contrasted with its surface condition resulting from cultivation, has been found by the writers in a few instances to be the critical factor, influencing not only the relative

[2]The investigations since 1922 have pertained primarily to the red-backed cutworm (*Euxoa ochrogaster* Gn.) but have also dealt with nearly all of the cutworms of economic importance in Saskatchewan. Previous experience with other noctuid species in two widely diverse environments further confirms these conclusions.

[3]Seamans, H. L.; The Pale Western Cutworm: Canada Dept. of Agric. Pamphlet No. 71, n.s., 1926, p. 3 and 6.

abundance but also the proportions by species in different parts of the same enclosed area of otherwise apparently uniform conditions. Similar significant differences between the cutworm populations of knolls and hollows, apparently induced by differences of drainage and insolation in their direct and indirect effects, have been found even where the soil type seemed the same. Relatively minor fluctuations of cutworm population recurring at small space intervals in a field are commonly encountered and may be discounted. On the other hand, any marked variations either in abundance or in proportion by species in different parts of an area should be considered significant even when no explantion can be offered for them.

A single collection, obtained and reared in the way described below, gives, if an adequate number of larvae is taken, a relatively accurate picture of the conditions as they existed in the field in question on the date of collection. This work may then be extended by means of similar collections in the same and other locations with three ends in view:—1. To follow the development of parasitism and disease with the advance of the season, in order to estimate the cumulative mortality. 2. To compare the results with those of other collections from the locality or district, to show the influence of environmental conditions. 3. To assist in the interpretation of less extensive data secured in other portions of the region involved.

The first of these aims is best accomplished by making successive collections of larvae in the same or "standard" field throughout the cutworm season. The results obtained afford excellent data on the development of disease and of infestation by parasites. These collections are started as soon as it is possible to find the young larvae, and are continued at intervals of a week or ten days, throughout the season of the species under study. Otherwise such parasites or diseases as attack either the early or the late larvae alone will be overlooked and the true cumulative mortality will not be obtained. In following this plan it is essential to choose a "field" sufficiently large and heavily infested that the successive collections will not seriously decimate the cutworm population. Otherwise the true natural balance is upset, probably increasing the rate of parasitism and decreasing the mortality due to disease. Whenever possible, as in years of heavy outbreaks, it is advisable to select for the "standard" a field representative of the outstanding crop of the area, in Saskatchewan a field of wheat or other grain, thus making the results more readily comparable from year to year.

If time and the availability of heavy infestations permit, valuable results are secured by selecting for successive collections several fields differing somewhat in environmental factors. Single collections may also be taken in many fields representing a wide variety of conditions, for comparison with each other and with the "standard" collections of the same date. In this, the experimental ideal of variation of but a single factor at a time should be kept in mind. This work should be carried on in the same immediate district so that the results may not be obscured by the effects of critical differences in meteorological factors.

It is frequently desired, in connection with a widespread outbreak of a destructive species, to gain some idea of the conditions throughout a large region. The data gained by intensive quantitative work in one district assume great value when attempting to interpret the results from scattered single collections, especially if studied in conjunction with a careful comparison of the current meteorological conditions in the several areas. Such scattered single collections are most significant when it is possible to take them as the cutworms are nearing maturity.

Methods of Making a Single Collection

In order to make a collection representative, the cutworms should be taken from a number of different locations or plots in the "field" under study. The size of the plot to be examined at each location may be determined either by the method of unit number or by that of unit area. In the first instance, the search is continued in each location until the selected number of cutworms, usually five or ten, has been secured. In using the second method, the size of the unit area is first selected after preliminary examination with reference to the rate of infestation, and then is kept uniform throughout the field; a plot of one or two square feet is usually convenient. The method of unit area[4] requires little more time, and permits quantitative data to be secured not only with respect to the density of the cutworm population, which is of great importance in relation to the spread of disease, but accurately reflects its composition as to species, and the number of injured and uninjured plants of the different kinds. In this way definite information can also be obtained with respect to predators, the prevalence of which can only be estimated by field observations.

If sufficient locations are taken they may well be determined by chance by taking them at definite intervals, or it may be preferable to

[4]An instance of the results obtained in a specific instance by use of this method is given by King and Atkinson, Scientific Agriculture, VII, Nov. 1926. p. 87.

select several locations which appear representative of the whole area as to important environmental factors. We have found that a combination of the two is usually of advantage, selecting each plot to be typical of its general location as determined by systematic sampling of the whole field. The plots in seeded fields must be chosen to include proportional parts of row and interspace.

Notes should be taken at the time of collecting, not only on the general field conditions already referred to but also on the individual plots, because of the effect of various environmental influences or natural control factors. Notes on the vegetation of the areas from which the larvae are taken, including under this heading both the crop and weeds and their stages of development, are important in relation to the percentage of parasitism, particularly by tachinids, such as *Gonia* spp., which oviposit on foliage. The actual significance in each case can only be determined by local observations on the habits of the flies concerned. The condition of the soil as regards moisture, temperature and looseness may influence parasitism and disease directly as well as indirectly through its effect on the relative stage of development of the host larvae.

Representative plots having been selected, the soil in each should be subjected to a careful examination in order to secure all the cutworms present. The tendency, particularly if the soil is wet, is to overlook the smaller larvae and those at some depth, with the result that the conditions existing at the time of collecting are not truly reflected.

The most essential point in manipulation is that each larva must be kept isolated from all others from the moment of collection until maturity. When near to headquarters each larva is put into a one or two ounce salve tin without either soil or food. When on a field trip of several days duration each larva is put into an individual tin, as before, but with a small amount of fairly dry soil and of some suitable food plant. The larvae can then be left for three or four days without attention. Record numbers or such other data as are necessary are written on each tin and the larvae are brought back to the laboratory for attention and rearing.

Records of the approximate stages of development of the larvæ are of value and may be made either in the field or during the preliminary sorting in the laboratory. With experience very accurate estimates can be quickly made for a species which has been studied in all instars.

Size of Collection

The size of collection required in any instance is determined in great measure by the accuracy of the method of collecting and rearing and by the number of collections taken, as well as by the time available. As in other quantitative work, the chief value of any collection or "sample" of cutworms lies in its comparison with other similar samples.[5] In an investigation of this kind, this involves a compromise between the completeness of each sample and the securing of sufficient similar samples, in order to obtain the fullest comparative value with a minimum expenditure of effort. We have found that, when the careful technique recommended is employed, fifty larvae of a single species in each collection is a sufficient number to show with considerable accuracy the total rates of mortality from disease and from combined parasitism. The data from a single collection of this size are usually of little significance in relation to the percentage of parasitism by any one species, but a relatively accurate estimate of the prevalence of the various parasite species is made available by a careful interpretation and averaging of the results from the successive collections in the same field or from those in different fields of the same district. Occasionally it is advisable to secure one hundred cutworms, but usually greater efficiency of effort is secured by taking instead two collections of fifty larvae each, either on different dates or in different fields.

Although slight reference has been made here and there to different cutworm species, for purposes of the discussion above an unmixed infestation has been assumed. The conditions found in actual practice may be divided roughly as follows:—1. One or more major species, with or without one to several minor species of distinct though slight economic importance, all the species being readily and accurately distinguishable as larvae by experienced observers. 2. Occurrence of a group of species, the larvae being so closely related in appearance, habits, and stage of development, as to be separable only partially if at all, although this group as a whole is distinguishable from other major and minor species. Under the former circumstances the proportion of the various species is determined by the quantitative methods of search. The first fifty larvae taken of each major species are reared as a collection from the field in question; the occasional cutworms met with of a minor species are reared as a sub-group with other similar sub-groups secured in other fields, to give a general idea of the status of natural control of the species, or are sometimes discarded if the same

[5]Vide Allen, W. E.; The Investigation of Ocean Pasturage; in Ecology 2, p. 218.

species is a major one in other nearby fields. Where an important but confused group, made up of several species in varying proportions, is encountered, a collection is made of a hundred or more larvae of the group; this is reared as a unit but is subdivided as far as possible, especially when greater maturity of the larvae renders identification easier.

Methods of Rearing

The larvae are reared in the laboratory in the tins in which they are placed in the field. All soil cutworms are reared with a moderate amount of soil in the cans. The most desirable soil is a sifted sandy loam which will not form into lumps. The soil is brought into the laboratory some time in advance and allowed to dry out, which lessens the probability of introduction of disease. Small quantities are moistened as required for use. The tins are filled half full of this soil; when larvae have been brought in with soil this is replaced by the laboratory soil.

White Dutch clover is used as food for most of our cutworms. Its advantages are that it is easily obtainable locally from the lawns, is readily eaten by most larvae, keeps fresh for several days and, especially if cut when dry, gives no indication of favouring disease. We possess, also, good evidence that parasites are seldom, if ever, introduced by the use of this food. The ideal, we admit, is that the food should be grown in a greenhouse but, when working with many larvae, this is impractical.

The soil is kept near the optimum moisture content which, it should be noted, varies for different species and can only be determined by experiment or observation. While perhaps the optimum temperature conditions for each species would be more desirable, our laboratory temperatures, ranging from 60 degrees F. to 75 degrees F. prove very satisfactory. The trays containing the tins are all kept together to obtain uniformity in this latter respect.

Treated in this way, the larvae require attention only every third or fourth day and may, if it is necessary, be left for five or six days without suffering serious harm. Ordinarily the soil is not changed at all but the main debris is removed before adding fresh food. Where there is evidence of disease among the larvae two or more pairs of forceps are used for handling them and are constantly sterilized in alcohol or some other disinfectant. Care must be taken not to assume that larvae from which no parasites seem to have emerged in the soil have died from disease, since some of these parasites, particularly those of the younger cutworms, may very easily be overlooked.

As a guide to when moths are likely to emerge it is handy to write the date of pupation on each tin though the darkening of lightly chitinized pupae also serves as a very good guide. Excellent moth emergence is secured by putting out the tins containing nearly mature pupae under gauze-covered lamp chimneys or inverted glass sealers. When working with a large number of pupae economy of labour may be effected by putting out the nearly mature pupae in the ordinary deep one-ounce salve boxes (3/4 inch high) in which they have been reared and covering them with sheets of glass. A little soil is left in the cans and moistened occasionally. As the moths emerge the determinations are checked before removing the glass. If the glass is kept covered with dark paper except at the time of examination very few moths are lost at the time of removal.

Dissection of larvae taken in the field is frequently a valuable supplement to rearing. It is seldom a satisfactory substitute, however, because it does not permit the recognition of the early stages of disease, nor afford evidence on the outcome of superparasitism (*s. lat.*) involving either two insect parasites or a combination of insect parasitism and disease.

Instances of Practical Application

Though the methods outlined above sound rather elaborate in description they are not complicated in their application. Moreover, from the standpoint of entomological technique they are entirely desirable if not always essential, for otherwise there is always the possibility of artificial infection by disease, of the introduction of parasites, or of cannibalism. They are the only methods we have devised for *Euxoa ochrogaster* which can be relied upon to furnish significant results.

Larvae of *E. ochrogaster* are very susceptible to several diseases and, when warm wet weather occurs and larvae are abundant, epidemics may develop which spread with great rapidity. While the manner of infection is not established, it is undoubtedly favoured by the massing together of many larvae. In 1923, a year with a rather wet May and a very warm wet June, we failed to rear moths or parasites from any of forty larvae collected at Rosthern, fifty miles north of Saskatoon, on June 26th. These larvae were placed several in a can until they were brought back to Saskatoon a day or two later, and the mortality was undoubtedly very much higher than that occurring in the field.

The results of 1923 contrast strongly with those of 1925, a year in which disease was far more prevalent in the field but in which the

recommended technique had been fully adopted. The percentages of larvae dying from disease and succumbing to parasites in four successive collections, the last three of which were made from a "standard" field, the first from a very similar nearby field, all treated in the standard manner described above, is shown in Table 1.

TABLE 1.—MORTALITY OF LARVAE OF *E. ochrogaster* FROM FOUR COMPARABLE COLLECTIONS IN 1925

Date of Collection	Mortality from Disease	Mortality from Parasitism	Moth Emergence
May 15th	17%	21%	62%
May 26th	30	17	53
June 9th	54	22	24
June 25th	66	32	2

The results obtained in 1925 demonstrate, when compared with the lack of results in 1923, the effectiveness of the technique. They further illustrate well the valuable results which may accrue from successive periodic collections in the same field. The rate of parasitism throughout the season is truly reflected, this condition being confirmed by other data. The slight decline in parasitism between the first two collections is attributable to the difference of locations. Even in this rather lightly infested field, averaging 1.8 cutworms to the square foot on June 9th., the final or cumulative mortality of *E. ochrogaster* was more than 98 per cent.

A collection made on May 20th, 1925 from a different field showed a larval mortality, exclusive of parasites, of only 6 per cent although the average length of larval life in the laboratory was thirty-seven days, considerably longer than that of the average collection. It is evident that, in spite of the unusually long period of rearing, there was no material mortality resulting either from the artificial conditions or cross-infection in the laboratory from other collections in which disease was prevalent.

One more striking instance in 1925 may be mentioned showing how well the collections represented conditions at the time of taking the larvae. On June 10th eighty cutworms were taken from a field where they were very plentiful. Of these 60 per cent died of disease, parasites emerged from 22.5 per cent and 17.5 per cent were reared to moths. From a comparison with the data from the "standard" location, Table 1, and considering the much higher rate of infestation, a more rapid spread of disease and a very high final mortality was anticipated. This was confirmed by a thorough examination of this field on June 27th when

not a single living cutworm or pupa could be found there, disease having wiped them out.

Mention was made earlier of the dangers of cannibalism. While *E. ochrogaster* does not exhibit this trait strongly, larvae of other species, such as *Porosagrotis orthogonia*, will injure one another and even slight injuries generally prove fatal. Two collections of larvae were made in 1926 at Indian Head. In the first the larvae were confined together with soil and food in a good sized tin for two days and then separated. The larval mortality of this collection, exclusive of parasitism, was 36 per cent. Another collection made from the same field six days later, the larvae all being kept separate, showed a larval mortality, exclusive of parasitism, of only 2 per cent.

ON A HIBERNATING CAGE FOR INSECTS

By H. Prell, *Forstliche Hochschule, Tharandt (Saxony)*

In rearing different insects for scientific purposes sometimes difficulties are encountered which may be overcome by simple technical methods. While the rearing of insects during their feeding period is rather easy generally, heavy losses often occur during the long resting periods. These losses are especially serious during hibernation. Therefore in many investigations the care of hibernating insects needs special consideration.

When I studied the biology of some Diptera parasitic on European forest insects the method of handling puparia during hibernation assumed an exceedingly important role. *Phorocera agilis* R. D. (= *Parasetigena segregata* auct. nec Rond), a parasite of the nun moth (*Lymantria monacha* L.) and *Ernestia (Pauzeria) rudis* Fall., a parasite of the pine moth (*Panolis flammea* Goeze), are single brooded and pass almost three quarters of the year as puparia in the soil. During this resting period sometimes 90–100% of the puparia, which are hibernating artificially, are destroyed.

For lessening these losses, two methods of care seemed available. The first consisted of keeping the puparia under hibernating conditions as similar to those in nature as possible. The second consisted in trying to find methods which were adapted for hibernation, whether they had any resemblance to the natural conditions or not.

Generally the first scheme is followed. That is the reason why in Tharandt we started offering the hibernating puparia conditions superficially similar to the natural conditions by placing them in soil

or moss, in periodically moistening them when kept in closed rooms, or in burying them out of doors, etc. The results sometimes were satisfactory, but in most of the cases a considerable proportion of the puparia died either on account of drying out or through the development of moulds.

Not satisfied with these results, we decided to follow up the other scheme for hibernation, which disregarded the typical natural conditions and only gave attention to the physical advantages of certain natural conditions. In fact we thought it might be possible by simulating and accentuating the advantageous natural factors to obtain even better results than in nature.

In nature the hibernating pupae of different insects are not tightly packed in the soil, but they lie in cells; these cells are very conspicuous if they are represented by cocoons, made of silk or of faeces, but they are easily overlooked if their walls are not lined. If pupae or puparia which have been collected out of doors are placed in soil they really are not kept under natural conditions, since they are in close contact with soil on all sides. Packing in moss is better, because the contact is not so complete, yet even in this case the contact is more extensive than in a pupating cell.

This difference between real natural and so-called natural conditions seems to be of considerable importance. The tight contact between the buried puparia and the surrounding soil acts like a bridge for water and for many dangerous organisms such as bacteria, moulds, etc. While in nature the puparium within its cell after a heavy rainfall will be enclosed by a large air bubble saturated with water, in the artificial hibernating cage the water itself can reach the puparium. So when the hibernating cage is moistened the puparia very often will become quite wet and sometimes eventually drowned. At the same time the germs of disease wandering or growing in this water easily are able to attack the puparia. Finally in many hibernating cages the circulation of the air in the surrounding soil is lessened or even stopped by the moisture, thus developing detrimental conditions for the puparia and advantageous ones for the moulds. If on the contrary the soil in a hibernating cage is not moistened sufficiently, the puparia will dry out. Only a very careful moistening which requires much attention and very much time will lead to good results.

An apparatus which would avoid these difficulties should satisfy the following biological needs: (1) Procuring a permanently and equally moist atmosphere; (2) Avoiding every direct contact of the puparia,

etc., with fluid water; (3) Maintaining a permanent free air circulation. Further it should meet the following practical needs: (4) Reliable operation without much attendance; (5) Being easily cleaned and disinfected; (6) Moderate in price.

In 1913 I devised a hibernating cage to meet the preceding requirements.

The hibernating cage consists of four different separate parts, viz., a lower part, a screen false bottom (resting sieve), an upper part and a cover. The lower part (A) is a cylindrical watertight container which is to be filled partly with water. This container is covered by a wire

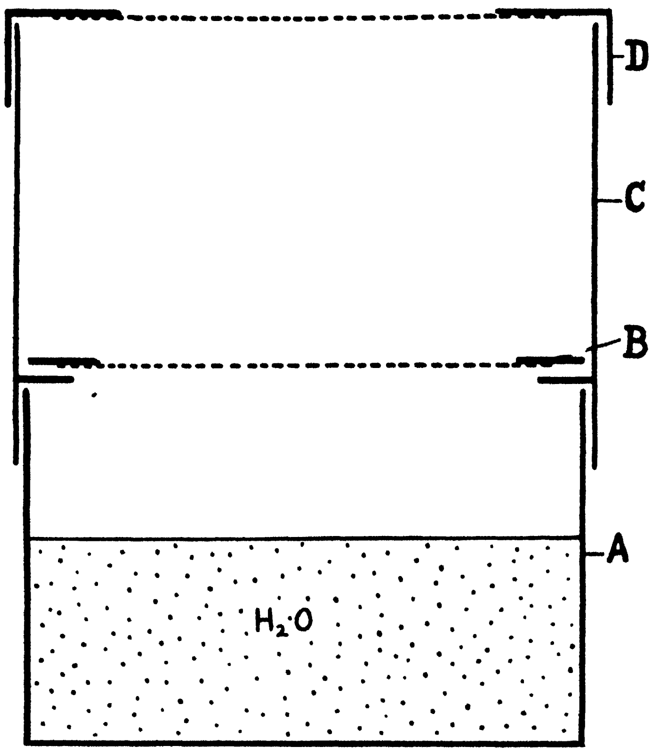


FIG. 40—Schematic diagram of hibernating cage.

screen false bottom in a zinc frame (B) on which the hibernating pupae, etc., are to be placed. This resting sieve at the same time forms the removable bottom piece of the upper part (C) resting on a ridge inside of the latter (upper part). The upper part is a cylindrical body which fits tightly on the container or lower part. It is closed by a detachable

cover (D) which is screened. The size of the whole apparatus can be adapted to any special requirements. Generally a cage of medium size having a diameter of about 5–6 inches is very convenient; smaller cages cannot contain so many pupae, while larger ones will be found not so handy.

As before mentioned, the pupae, etc., for hibernation are placed on the inner wire screen (B) without any surrounding soil or moss. One may add a very little moss in order to assist the emerging insects in shedding their pupal skins and in developing their wings, but it must be kept in mind that even sterilized moss is a good culture medium for the germs of diseases. If everything is properly prepared the hibernating cage operates automatically.

The water which is contained in the lower part continually evaporates and produces on its surface an atmosphere saturated with water. The walls of the lower and the upper part hold together this moist atmosphere so that there is only a small decrease of water content below the cover screen. Above the cover the decrease of the moisture will be very rapid and furthermore every slight motion of the air in a dry room will stop the evaporating moisture. So a continuous circulation of air is kept going on from the surface of the water around the pupae, etc., on the sieve up through the cover. The degree of this air current may be regulated by using covers with wire screens of different mesh; and furthermore it is possible by covering more or less of the upper screen to lower and finally to stop the air current. In this way the biological requirements seem to be fulfilled.

The moisture control by evaporation needs no continuous adjustment. It is only necessary from time to time to renew the water supply in the container, so the hibernating cage brings about a considerable reduction of work. If ever an infection by any disease occurs, it is quite easy to clean the whole apparatus. Every part can be separated from the others and disinfected by boiling, since the entire cage is made of metal. Finally, the price of this hibernating cage is very reasonable and if it is made of zinc with copper screen it will last for many years.[1]

So also the practical requirements seem to be fulfilled.

The results which we obtained in using the hibernating cage were fully satisfactory. The pupae of many different Lepidoptera and

[1]The cage may be cheaper still, if any commercial tins (cans) can be adapted to a similar combination, but in this case it will not last so long and is not so reliable. Another cheap but not so satisfying method consists in using a big glass jar with screen cover, in which is placed a smaller jar filled with water and carrying on its screen cover the hibernating pupae, etc.

Hymenoptera hibernated practically without any loss and even the puparia of Tachinidae gave about 100% emerging flies. After the first year's experience for hibernation we have placed all of the pupae and puparia in with hibernating cages which were kept in a dry room sheltered from the influence of frost.

Later we have tried to improve our method in two respects. The first improvement consists of the application of a short tube in the wall of the upper part on which a glass vial may be fixed as is used often in the rearing of parasitic insects in order to catch the emerging parasites. The second improvement consists of adapting the same hibernating cage for rearing a considerable number of different species which must be kept separate. For this purpose we use short glass tubes which on both ends are closed with gauze or mosquito bar and which are put vertically on the sieve.

Of course these hibernating cages cannot be used in the same way for all kinds of insects, since the amount of moisture required is often different, but for many of them at least hibernation is rendered quite easy. On the other hand, there is no question but that these hibernating cages also may be used as rearing cages for certain insects. By putting some soil on the sieve one is able to rear soil inhabiting larvae; by putting wood on the sieve it is possible to rear woodboring insects, which need a certain and permanent amount of moisture. Also in these cases the evaporating water automatically will maintain a more constant moisture than even the most careful spraying can produce.

No special mention is needed to show that the hibernating cage described is only the result of further development of methods already long in use by Lepidopterists for the hibernation of pupae. But upon visiting several entomological experiment stations, other investigators also complained of heavy losses of insects and especially of puparia of economically important Tachinidae occurring during their hibernation. For this reason it seems justifiable to describe the method by which at the Zoological Institute in Tharandt such losses were avoided to a large extent.

THE ENTOMOLOGICAL STATION AT TASHKENT, USBEKISTAN

By T. D. A. Cockerell

We arrived at Tashkent on Sept. 1, and left on Sept. 8, without having any opportunity to do much collecting. An excursion to the village Kujluk resulted in the capture of only a single species of bee, a *Tetralonia*. It was in fact the dry season, with conditions quite like those in late

summer in Southern California. The spring flora, as in California is rich and varied, with a great abundance and variety of bees and other insects. I was fortunately able to get a good idea of the Economic Entomology of Usbekistan (Russian Turkestan) through a visit to the admirable and well-equipped Entomological Station. This Station covers not only the field of Entomology, but also Phytopathology (I met N. G. Zaprometoff, specialist in diseases of cotton, grapes, etc.), and injurious vertebrates. I saw in cages the principal injurious mammals, one of the most important being a prairie-dog (*Cynomys fulvus oxianus* Thomas), very like our American species. Another important species is *Gerbillus eversmanni*. A species of *Ellobius*, burrowing in the soil, takes the place of the mole, which is absent. Porcupines are troublesome in gardens. Among the reptiles, a tortoise (*Testudo*) destroys young cotton. The crustacean *Porcellio ornatus* M. Edw. is very harmful to crops, especially young cotton. The slug *Agriolimax buchar* Simroth is bad on cabbage, etc. A much larger slug (*Parmacella levanderi* Simroth) is also complained of. Attention is also paid to the birds; I noticed mounted specimens of the beautiful *Pastor roseus*, useful as an enemy of grasshoppers. The Director of the Station is V. J. Plotnikoff, who is specially interested in Acridiidae. A very fine account of the grasshoppers of the region, by Uvarov of the British Museum, has been published by the Station. N. P. Nevsky, working at the Station, is a specialist in Aphididae. Just as I was leaving Tashkent I was informed that he had named a new aphid after me, as a memento of my visit. I met also Miss Alexandra D. Archangelsky, a student of Coccidae, who works in the Museum at Samarkand. She has found some very interesting new species, as might be expected in such a region; I was shown one which superficially appeared to be a *Takahashia*, and another of an unknown, perhaps new, genus. The various species of *Tamarix*, native in the region, are prolific in interesting Coccidae. As we passed through the thorny desert in the train, the pink flowers of tamarisk was almost the only blossoms visible in a dry and dusty landscape.

The Station has a very fine set of glass-covered mounts, showing the life-histories of all the local injurious insects. As I went over these I noted the principal ones, and was informed concerning their economic status. A partial catalogue may be of interest, especially as showing that even in this remote region the pests are in large part identical with those familiar in America.

ARACHNIDA—*Eriophyes piri* Pag., *E. vitis* Land, and *Tetranychus* labelled *telarius*, but it was explained to me that this determination had to be revised in the light of recent American work.

ORTHOPTERA—*Dociostaurus moroccanus* Thunb is their most harmful insect, but *Locusta migratoria* L. has been made the subject of a special bulletin. They were breeding the latter species in cages, and made the remarkable observation that the young hoppers were red when bred in numbers together, but green when bred alone. *Gryllus desertus* Pallas is an ordinary looking cricket. Mr. Plotnikoff specially called my attention to the very interesting (though economically unimportant) genus *Consphyma*, consisting of wingless forms recalling our short-winged *Melanoplus*. This genus includes a large number of local species; every mountain mass has two or three species, apparently. Fourteen species were known up to this year, but during the year Plotnikoff has found four new ones, and doubtless many others exist.

LEPIDOPTERA. *Carpocapsa pomonella* infests apples as with us. *Caradrina exigua* is a pest on alfalfa, *Heliothis obsoleta* is injurious to cotton, *Pieris brassicae* is not very destructive to cabbages; *Plutella maculipennis* is much worse, *Ocneria dispar* is found in the mountains, and occasionally in the valleys. Various species of *Coleophora* are troublesome; they have not yet been fully investigated. N. N. Filipjev of Leningrad has recently published one of them (*C. hemerobiola*) as new, showing that the female genitalia as well as those of the male afford excellent specific characters. *Cosmia subtilis* Stgr. is injurious to apricot. *Biston cinerarius* Ersch. is bad on mulberry. *Agrotis segetum* is an important cutworm, but other species occur.

DIPTERA. Several species of *Anopheles* exist, and malaria is endemic. *Oscinella frit*, *Mayetiola destructor*, *Pegomyia hyoscyami*, *Agromyza flaveola* and *Stenodiplosis panici* are noted among the Diptera injurious to crops.

HYMENOPTERA. *Eriocampoides limacina* is an important pest.

HEMIPTERA. *Dolycoris penicillatus* Horvath is a pentatomid bug of considerable importance; it usually lives on trees, but descends in swarms on the wheat and other crops. *Psylla piricola* is a serious pest on fruit trees. *Eriosoma lanigerum* is very injurious, and has been made the subject of a special bulletin. Other notable aphids are *Aphis pomi*, *A. gossypii*, *Pterschloroides persicae*, *Hyalopterus pruni*, etc. I was surprised to see a species of *Forda* forming galls. The collection of local Coccidae at the station, so far as identified, includes the following: *Gueriniella serratulae*, *Orthezia urticae*, *Pulvinaria artemisiae*, *P. betulae*, *P. orientalis* Nassonov (on *Salsola*), *P. pistaciae* (n. sp.), *Lecanium corni*, *L. persicae*, *Physokermes unifasciatus* Arch., *P. coryli* Ldgr., *Lecanium bituberculatum*, *Gossyparia ulmi*, *Asterolecanium variolosum*, *Aulacaspis*

rosae, *Eriococcus spurius* Ldgr., *Leucaspis riccae*, *Chionaspis salicis*, *Aspidiotus ephedrarum* Ldgr., *A. transcaspiensis* Marl. *A. brittanicus* Newsh (Miss Archangelsky says she is not quite sure of this determination), *Lepidosaphes ulmi*, *L. juniperi* Ldgr.

COLEOPTERA. *Rhynchites auratus* causes a loss of two million roubles a year (a million dollars) to the apricot crop. *Galerucella luteola* is bad on elms. *Zabrus gibbus* (Carabidae) was discovered to be injurious last year. *Phytonomus variabilis* infests alfalfa. *Potosia marginicollis* Pallas is a handsome *Cetonia*-like scarabaeid, which injures fruit, especially apples. *Aeolestes* (or *Pachydissus*) *sartus* is a troublesome cerambycid borer in wood. The larvae of *Polyphylla adspersa* Motsch attack the roots of plants. The chrysomelid *Agelastica orientalis* Baly occurs on various trees.

A species of thrips is very bad on cotton.

In addition to the central station, there are fifteen local stations, each for the investigation of some particular problem or set of problems About seven kilometers from Tashkent is a very good cotton-breeding station, where problems connected with cotton are intensively studied.

The workers at the station highly value the American publications on Economic Entomology, and welcome American cooperation. With conditions so similar to those in certain parts of the United States, and so many pests in common, it is obvious that there should be many opportunities for advantageous cooperation, as for instance in reference to matters of biological control.

COMMON NAMES OF INSECTS APPROVED FOR GENERAL USE BY AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

SECOND SUPPLEMENT TO LIST APPEARING IN VOLUME 18, PAGES 521–545, 1925

The following list of common names was prepared by the Committee on Nomenclature of the American Association of Economic Entomologists in conformity with instructions given by the Association at its last regular meeting. A list of 56 names was submitted to the members of the Association and of these names the following 42 have met with their approval:

Key to Symbols

A—Acarina	H— Hemiptera	L— Lepidoptera
C—Coleoptera	Hy—Hymenoptera	M—Miscellaneous
D—Diptera	N— Neuropteroids	O— Orthoptera

Insects Listed by Common Names

American dog tick A	Dermacentor variabilis Say
Apple sucker H	Psylla mali Schmid.
Blueberry flea beetle C	Haltica torquata Lec.
Brown dog tick A	Rhipacephalus sanguinius Latr.
Cattle biting louse M	Trichodectes bovis L.
Cat flea M	Ctenocephalus felis Bouché
Chicken body louse M	Menopon stramineum Nitz.
Chicken head louse M	Lipeurus heterographus Nitz.
Chigger A	Trombicula irritans Riley
Clover seed midge D	Dasyneura leguminicola Lint.
Corn root webworm L	Crambus caliginosellus Clem.
Cotton leaf worm L	Alabama argillacea Hbn.
Cottonwood leaf beetle C	Lina scripta Fab.
Cowpea aphid H	Aphis medicaginis Koch
Dog flea M	Ctenocephalus canis Curtis
Eastern field wireworm C	Pheletes ectypus Say
Eggplant flea beetle C	Epitrix fuscula Crotch
Fire brat M	Thermobia domestica Pack.
Fluff louse M	Goniocotes hologaster Nitz.
Fork-tailed bush katydid O	Scudderia furcata Brun.
Green-striped maple worm L	Anisota rubicunda Fab.
Horse biting louse M	Trichodectes equi L.
House centipede M	Scutigera forceps Raf.
Itch mite A	Sarcoptes scabiei DeG.
Mormon cricket O	Anabrus simplex Hald.
Nose bot fly D	Gastrophilus haemorrhoidalis L.
Olive fruit fly D	Dacus oleae Rossi
Prairie grain wireworm C	Ludius aereipennis Kby.
Rose leafhopper H	Empoa rosae L.
Rose root gall Hy	Diplolepis radicum O. S.
Scab mite A	Psoroptes communis Fürst.
Sheep bot fly D	Oestris ovis L.
Silver fish M	Lepisma saccharina L.
Sorghum midge D	Contarinia sorghicola Coq.
Sorghum webworm L	Celama sorghiella Riley
Southwestern corn borer L	Diatraea grandiosella Dyar
Steel-blue ladybeetle C	Orcus chalybeus Bdv.
Strawberry root aphid H	Aphis forbesi Wied.
Two-spotted ladybeetle C	Adalia bipunctata L.
Throat bot fly D	Gastrophilus nasalis L.
Webbing clothes moth L	Tineola biselliella Hum.
Wheat joint worm Hy	Harmolita tritici Fitch

Insects Listed by Scientific names

Adalia bipunctata L	Two-spotted ladybeetle
Alabama argillacea Hbn	Cotton leaf worm
Anabrus simplex Hald	Mormon cricket
Anisota rubicunda Fab	Green-striped maple worm

Aphis forbesi Wied	Strawberry root aphid
Aphis medicaginis Koch	Cowpea aphid
Celama sorghiella Riley	Sorghum webworm
Contarinia sorghicola Coq	Sorghum midge
Crambus caliginosellus Clem	Corn root webworm
Ctenocephalus canis Curtis	Dog flea
Ctenocephalus felis Bouché	Cat flea
Dacus oleae Rossi	Olive fruit fly
Dasyneura leguminicola Lint	Clover seed midge
Dermacentor variabilis Say	American dog tick
Diatraea grandiosella Dyar	Southwestern corn borer
Diplolepis radicum O. S	Rose root gall
Empoa rosae L	Rose leafhopper
Epitrix fuscula Crotch	Eggplant flea beetle
Gastrophilus haemorrhoidalis L	Nose bot fly
Gastrophilus nasalis L	Throat bot fly
Goniocotes hologaster Nitz	Fluff louse
Haltica torquata Lec	Blueberry flea beetle
Harmolita tritici Fitch	Wheat joint worm
Lepisma saccharina L	Silver fish
Lina scripta Fab	Cottonwood leaf beetle
Lipeurus heterographus Nitz	Chicken head louse
Ludius aereipennis Kby	Prairie grain wireworm
Menopon stramineum Nitz	Chicken body louse
Oestris ovis L	Sheep bot fly
Orcus chalybeus Bdv	Steel-blue ladybeetle
Pheletes ectypus Say	Eastern field wireworm
Psoroptes communis Fürst	Scab mite
Psylla mali Schmid	Apple sucker
Rhipacephalus sanguinius Latr	Brown dog tick
Sarcoptes scabiei DeG	Itch mite
Scudderia furcata Brun	Fork-tailed bush katydid
Scutigera forceps Raf	House centipede
Thermobia domestica Pack	Fire brat
Tineola biselliella Hum	Webbing clothes moth
Trichodectes equi L	Horse biting louse
Trichodectes bovis L	Cattle biting louse
Trombicula irritans Riley	Chigger

Scientific Notes

Vitula serratilineella **Ragonot on Dried Fruit in California.** In 1903, Dyar[1] stated that dried fruit received at the Department of Agriculture from Santa Clara County, California, was found to be infested by larvae of *Vitula serratilineella* Rag. This article is chiefly descriptive of the egg and the larva of this insect.

During the past three years, an occasional specimen of an unknown moth has been taken in the vicinity of stored dried fruit but efforts to breed the species were unsuccessful, mainly because of scantiness of material. In the fall of 1924, dead specimens were taken among stored prunes in a warehouse at San Francisco subsequent to hydrocyanic acid gas fumigation. During the summers of 1925 and 1926, two or three specimens were also collected at Fresno. In February, 1927, specimens of an unknown larva were brought to the writers' attention by Mr. James MacKay, superintendent of the American Seedless Raisin Company's packing plant at Del Rey. These larvae attracted his attention by being considerably larger than larvae of *Plodia interpunctella* Hbn., the common dried fruit pest. They were reported as occurring on stored raisins, but in very small numbers. Two adults, both males, emerged about the middle of April from the larvae sent Mr. MacKay. At Fresno, two females were collected at fig packing establishments on March 16 and 27, respectively. From the 94 eggs obtained from the latter female rearings were started and the following life-history data obtained.

The eggs are placed on raisins in a manner very similar to those of the Indian-meal moth. Eggs laid at the end of March hatched in 10 to 11 days. The resulting larvae pupated after 52 to 108 days, averaging about 69 days for the larval stage. The pupal period lasted 8 to 12 days, the adults emerging from June 11 to July 1. The preoviposition period ranged from 1 to 10 days, but was mostly 1 to 3 days. Each of 10 females deposited from 32 to 200 eggs, averaging about 102 eggs per female. During late June and early July these eggs hatched in 4 to 6 days. Emergence of adults of the second summer generation began on September 2.

From these fragmentary data we see that the species breeds slowly in the San Joaquin Valley, having only two generations during the long summer, and a total of three generations throughout the year. The species overwinters in the larval stage. In our rearings the average number of eggs deposited was small, the hatch very poor, and the larval mortality great. These circumstances together with its slow development appear to account for the scarcity of the species in the Fresno district.

J. C. Hamlin and W. D. Reed,
Bureau of Entomology, Fresno, California.

Calcium Arsenate as a Cause of Aphis Infestation. When dusting with calcium arsenate became prevalent for control of the boll weevil in cotton, it was noticed that excessive applications of calcium arsenate were often followed by heavy infestations of the cotton louse (*Aphis gossypii* Glov.). The actuality of this relation was demonstrated in field experiments planned and directed by Mr. B. R. Coad, in charge of cotton insect investigations of the Bureau of Entomology, at Tallulah, La.

[1]Note On A California Fruit Moth, by Dyar, H. G., Proc. Ent. Soc. Wash., Vol. 5, p. 104, 1903.

These extensive experiments, conducted from 1924 to 1926, inclusive, and involving 65 acres of plats, showed the dependence of aphis multiplication upon the number of applications of calcium arsenate and the time of the season at which the applications were made. They showed also that the regular, or commercial, number of applications did not produce injurious infestations, and that an infestation could easily be checked with a nicotine mixture.

The causal connection between calcium arsenate dusting and aphis multiplication has been a puzzle. The evident hypothesis is that the arsenate diminishes factors that normally check the reproduction of the lice. We could find no evidence in our experiments of 1925 and 1926 that plant condition, meteorological influences or disease had anything to do with the matter; so we studied chiefly the natural enemies of the louse. The insect enemies number some 60 species, dominated as usual by Coccinellidae, Syrphidae, Chrysopidae and parasitic Hymenoptera.

One might think that calcium arsenate would operate to kill off the predatory enemies of the cotton louse. As a matter of fact it did not. Coccinellids, syrphids and chrysopids were conspicuously more abundant on dusted plats than on check plats, and sweepings showed that these predators increased in number with their host.

For the purpose of catching insects that might be killed by dusting, cloths were spread under cotton plants and held down under each plant by a fence-like frame of boards, four feet square. After dusting, these "trays" were examined every few hours and for several days, with the result that dead insects were not found in them. A few insects or spiders entered the trays accidentally, but that was all. The predators were not killed by the dusting.

Of hymenopterous parasites, *Aphidius testaceipes* was most abundant, attaining its maximum numbers June 17–July 1 and August 4–15, in 1925. Lice parasitized by this species were scraped from cotton leaves, incidentally with more or less calcium arsenate, and kept in Petri dishes for the study of emergence. The parasites upon emerging struggled about in the arsenate and died. They died also in the open air in the presence of calcium arsenate. Under a microscope the dust could be seen on the legs and body, abundantly when there was dew on the leaves, and the parasites often drew the feet through the mouth. Grains of arsenate were not observed in the spiracles, and most of the grains were too large to enter the spiracles. There remains, however, a possibility of spiracular poisoning or clogging. The parasites were killed not only by calcium arsenate but also by other dusts, some of which were inert. Calcium arsenate killed them in 21 minutes, on an average; calcium hydroxide, in 33.7 minutes; calcium carbonate, with two per cent of Paris green, in 38.1 minutes; corn starch, in 65 minutes; and calcium carbonate, in 66 minutes.

A second important primary parasite of the cotton louse was *Pachyneuron siphonophorae*. This was most abundant during the first week of July and in September and October, when *Aphidius testaceipes* was uncommon. *Pachyneuron* was killed in the same manner as *Aphidius* by dusts on the leaves. Calcium arsenate killed it in 38 minutes and calcium carbonate, in 68 minutes; whereas corn starch required from 6 to 12 hours.

The effect, then, of dusting with calcium arsenate was to favor the multiplication of the cotton louse by reducing the numbers of its most important parasitic enemies.

Before parasitism appeared, however, the cotton louse was much more abundant on dusted plants than on undusted. Winged lice appeared on the former a few hours

after dusting, but not on the latter; and two dustings, three days apart, gave a moderate infestation in a week or so. This had to be accounted for.

A clue was found, at the time of dusting with hand guns, when winged female lice were now and then seen to fly like a shot at patches of arsenate on the leaves and remain there. This suggested tests for positive phototropism.

Single plants which were dusted became heavily infested; but the surrounding undusted plants were not infested. Infestations were induced not only by means of calcium arsenate but also with calcium carbonate, starch and flour, on individual plants. Then large-scale dusting experiments were made, for the comparison of calcium arsenate with another dust, that should be white, but inert. Cuts of cotton were laid out, each of about three acres, divided into three equal plats: (1) a check plat; (2) a calcium-carbonate plat; (3) a calcium-arsenate plat. The percentages of infestation were arrived at by means of a system which expressed a composite figure representing: (1) the percentage of plants infested, (2) the number of infested leaves per plant, and (3) the average infestation per leaf. In estimating the leaf infestation ten grades of infestation, represented by a standard series of ten photographs, were used. In 1925 both dusted plats developed eventually 100 per cent infestation, probably for the reason that the only immediately available carbonate contained 2 per cent of Paris green (for use in *Anopheles* dusting). In 1926, pure carbonate was used, on the two cuts, M and K. Cut M was dusted seven times, July 3 to August 14, using each time an average of 17 pounds of calcium carbonate and six pounds of calcium arsenate. The initial and final percentages of infestation were as follows:

	1. Check	2. Calcium carbonate	3. Calcium arsenate
July 3 (original infestation)	0.7	0.3	0.1
Aug. 20 (final infestation)	38.	78.	95.

The high infestation of the calcium-carbonate plat was probably due to the fact that the plat had to be poisoned for the leaf worm on August 11.

Cut K received no Paris green, and was dusted eight times, June 11 to August 14, with 13 pounds of Calcium carbonate and 8 pounds of calcium arsenate. The percentages of infestation were:

	1. Check	2. Calcium carbonate	3. Calcium arsenate
June 11 (original)	3.3	2.	1.3
Aug. 20 (final)	18.	25.2	69.

Always the calcium-arsenate plat and the calcium-carbonate plat became infested at the same time after dusting, and the infestation developed equally on the two plats until parasitism began; thereafter infestation became gradually greater on the calcium-arsenate plat than on the calcium-carbonate plat.

As another phototropic test, plants were dusted with calcium arsenate that had been colored green to resemble leaves. These plants remained uninfested; but adjacent plants dusted with white arsenate became infested in three days. In five to ten days, however, the green calcium-arsenate faded to almost white in the sunlight; then infestation came.

It has often been observed that aphis infestation becomes more intense on small areas of dusted cotton (as on experimental plats) than on large dusted areas of hundreds or thousands of acres. An explanation of this would be that the positive phototropism of the aphids causes them to concentrate on white areas of cotton

that are relatively small; but where all the cotton in a district is whitened, the aphids have no opportunity for selection.

SUMMARY.—Excessive applications of calcium arsenate are often followed by heavy infestations of the cotton aphis. The initial infestations are due to the positive phototropic reaction of winged females to white substances, such as calcium arsenate, calcium carbonate, starch or flour. A heavy infestation is built up, not by the destruction of predators by calcium arsenate, but by the killing of hymenopterous parasites when they emerge in the presence of the arsenical. They are killed also, though more slowly, by calcium hydroxide, calcium carbonate and corn starch.

J. W. FOLSOM, *Entomologist, Cotton Insect Investigations, Bureau of Entomology.*

***Pseudococcus maritimus* Ehrhorn, a pest of Gladiolus and Calla.** In late May, 1925, several hundred dormant Gladiolus corms from storage were brought into the laboratory by a local florist whose stock of 1500 bulbs was heavily infested with mealy bugs. The insects, their egg masses, and the fluffy wax, nearly covered the corms beneath the outer covering of dead leaf scales. All of the corms were shrivelled, due, evidently, to the feeding of the mealy bugs as no scab or other disease seemed to be present. The florist stated that he observed an occasional mealy bug on the roots when digging the crop the preceding fall and that breeding had progressed in the storage cellar during the winter.

About the same time a similar infestation of mealy bugs on 2000 Gladiolus corms were examined at a greenhouse in Philadelphia where they were being stored over winter beneath a bench. In early March the florist had placed near the Gladioli about 300 Calla Godfrey plants for drying off, after knocking them out of the pots and leaving the soil ball about the roots intact. At the time of the writer's visit, the corms of the Callas within the soil ball were very heavily infested with a mealy bug and the whole plant parts were in a badly shrivelled condition similar to that of the Gladioli. Neither florist attempted to eradicate the insects as a means of saving their stock but destroyed it because they considered the injury too severe for recovery of the plants.

In July, 1927, a third infestation, but very light and apparently doing no damage, was found in some stored Gladiolus stock at Willow Grove.

Material from the 1925 infestations were examined and the mealy bug was identified as *Pseudococcus maritimus* Ehrhorn by Mr. F. M. Trimble, Chief Nursery Inspector, Bureau of Plant Industry, Harrisburg, Pa. Specimens from the 1927 infestation were similarly identified and this determination was verified by Mr. Harold Morrison, U. S. Bureau of Entomology. Since there were no available records of this insect being an economic pest it was considered advisable to investigate methods for its control. In 1925 a few tests were conducted with infested Gladioli and the following results were observed.

A. Hot water immersion of corms.

May 13.						Effect on insect after 4 days
Water 44–45° C.	10 minutes exposure	25 corms	6 dead	85 living		Eggs hatched later.
" 47–48° C.	10 " "	25 "	67 "	0 "		50% of eggs hatched later.
" 51–52° C.	10 " "	25 "	84 "	0 "		No eggs hatched.
Check—no treatment		60 "	0 "	60 "		Eggs hatched later.

B. Immersion in Kerosene Nicotine Oleate.					
May 13.					
Water 20° C. 5% emulsion,	10 min. ex.	25 "	38 "	0 "	No eggs hatched later.
" 20 ° C. 2.5% "	10 "	25 "	33 "	11 "	Eggs hatched later.
Check—No treatment	50 "	0 "	41 "		"
C. Immersion in Ivory Soap Emulsion (1 gram per 100cc.)					
May 13.					
Water 20° C.	10 minutes exposure	25 corms	10 "	86 "	Eggs hatched later.
Water 45° C.	10 " "	25 "	50 "	10 "	Eggs hatched later.
D. Nicotine Sulphate (1–800) plus Fish Oil Soap. (2 lb. per 50 gal.)					
May 13.					
Water 20° C.	10 minutes immersion	25 corms	1 dead	165 "	Eggs hatched later.

After examining the insects, the corms with the mealy bugs still adhering were planted out of doors. However, all the corms including the checks were in such condition that only weak growths were made and these soon died down with the rotting of the roots. The preceding tests are therefore not presented as conclusive but merely as suggestions to others who may wish to eradicate this pest should it be encountered on stock less severely injured than was that at hand for our work.

FLOYD F. SMITH,
Willow Grove, Pennsylvania (Penna. Bureau of Plant Industry).

Lilac Leaf Miner, *Gracilaria syringella* Fabr. Lilac and privet leaves badly mined and curled were received in August from Mr. R. E. Horsey of Highland Park, Rochester. He stated that in some cases every leaf on a lilac bush was dried or curled up, while in others every leaf was infested and but little green tissue remained. Reared adults were identified by Dr. August Busck of the U. S. National Museum.

Later Mr. Horsey stated that this species has been reported from all over the city of Rochester and on August 28th he saw in the reservation at Niagara Falls, a number of lilacs infested with what he believes to be the same insect. Work of this species was also received the last of August from Albert P. Morse, Curator of Natural History, Peabody Museum, Salem, Mass., accompanied by the statement that the lilacs in that section looked quite disreputable.

E. P. FELT

Keeping Quality of Prepared Grasshopper Baits. Prepared grasshopper poison was studied and reported by D. B. Mackie in 1919 (California Monthly Bulletin, Vol. IX, No. 5–6, pages 194–197). A formula reported by Mr. Mackie as satisfactory in his tests consisted of:

White arsenic.................................1 lb.
Finely ground orange pulp.......................5 lbs.

This mixture was sealed in tin cans for storage and it was recommended, when used, to mix the contents of one can with 25 lbs., of bran and sufficient water to make up a mash of the desired consistency.

Successful tests with this material were made in Arizona and Colorado, as well as in California. It will be noted that no molasses was used but, instead of this, more orange pulp was used; otherwise, the ingredients were similar to the government formula.

The formula having been tested and found to be effective, the next interesting point is how long the material will keep. As far as my information goes, no records have been made of its keeping quality for longer than one year.

The devastating grasshopper, *Melanoplus devastator* Scud., became so abundant this summer that control measures had to be undertaken. Some prepared poison bait, which had been made in 1919 by Orange Products Company and had been stored for the past eight years on the ranch of Mr. G. H. Hecke, Director of Agriculture, was tried in this work.

The cans were in perfect condition except that the ends were bulged apparently from fermentation which had taken place within. The mash was prepared at greater than the recommended strength and broadcast in the usual manner. Much to our surprise, very successful results were obtained, equalling any that were obtained with freshly mixed material made with the government grasshopper bait formula using Paris Green.

It is evident from this observation that prepared grasshopper baits may be stored in tin cans indefinitely without losing their attractiveness or effectiveness for grasshopper control. The ease with which this material is mixed and the length of time it may be stored without deterioration makes it a valuable addition to our control materials.

FRANK E. TODD, *Entomologist, California State Department of Agriculture*

ENDOWMENT FUND NEWS

The endowment committee has invited one member in each State and in each Province in Canada to organize the members in his own territory to assist in raising the endowment.

The following have responded favorably:

Alabama—Prof. J. M. Robinson, Box 264, Auburn.
California—Prof. E. O. Essig, Agricultural Hall, Univ. of Calif., Berkeley.
Colorado—Prof. Geo. M. List, Agri. Exp. Station, Fort Collins.
Connecticut—Dr. W. E. Britton, Agri. Exp. Station, New Haven.
Georgia—O. I. Snapp, Bureau of Entomology, Fort Valley.
Indiana—Prof. J. J. Davis, Agri. Exp. Station, Lafayette.
Iowa—Prof. C. J. Drake, State College, Ames.
Mississippi—Prof. R. W. Harned, Agricultural College.
Nevada—Prof. C. W. Creel, Extension Div., University of Nevada, Reno.
New Hampshire—Prof. P. R. Lowry, Durham.
New Jersey—L. B. Smith, Moorestown.
North Carolina—Prof. Z. P. Metcalf, West Raleigh.
North Dakota—J. A. Munro, State College, Fargo.
Oregon—Prof. Leroy Childs, Hood River.
Utah—George I. Reeves, 473 Fourth Ave., Salt Lake City.
Virginia—Prof. W. J. Schoene, Agri. Exp. Station, Blacksburg.
Wisconsin—Prof. H. F. Wilson, University of Wisconsin, Madison.

Canada

Manitoba—Prof. Norman Criddle, Treesbank.
Quebec—Dr. W. H. Brittain, Macdonald College.
Saskatchewan—Prof. K. M. King, Entomological Laboratory, Saskatoon.

Replies from other States and Provinces will doubtless be received before this issue of the Journal is printed but the above list covers those that arrived before going to press.

One member of the Association suggests that when any member wishes to dispose of his library he might donate it to the Association so that it could be sold and the proceeds turned into the endowment fund. This idea might be adopted to advantage in cases where the books were located where they could be disposed of by some member of the Association without the necessity of incurring expense for long distance shipment. It is probable that there are members who have duplicate copies of rather rare books or reports that they would be willing to donate for the benefit of this fund. It is possible that some of the members might secure valuable collections of insects that could be handled in this way. The committee will welcome suggestions from any and all sources.

The endowment fund now totals over $5,000, which is an increase of over $1,000 during the past year.

One application for life membership has been received during the past month.

A. F. BURGESS,
Chairman, Endowment Committee

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1927

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

One hundred separates or reprints at $1.50 per page or plate. Additional hundreds or less, 4 pages or less, $1.00; 5–8 pages, $1.50; 9–12 pages, $1.75; 13–16 pages, $2.00; 17–24 pages, $3.00; 25–32 pages $4.00. Covers suitably printed on first page only, 100 copies, or less, $4.50; additional hundreds, or less, $1.75. Plates inserted, $1.75 per hundred or less. Folio reprints, the uncut folded pages (50 only), sixteen page signature, or less, $3.00. A discount of 10 per cent and 20 per cent from the above prices will be allowed on orders of 500 and 1000 reprints respectively.

The Fourth International Congress of Entomology is to be held in August, 1928, at Cornell University, Ithaca, N. Y. Previous Congresses have met at Brussels (1910), Oxford (1912) and Zurich (1925). Every important interest—educational, scientific and economic will be provided for in the program. Invitations have been forwarded through the state department to foreign governments to send representatives and later invitations will also be sent to the individual entomologists. A program will be arranged in which some of the leading entomologists of the world will take part. It is planned that in the forenoons throughout the week papers of general interest are to be read before the members of the Congress. In the afternoon there will be sectional meetings dealing with (1) Taxonomy, distribution and nomenclature, (2) Morphology, physiology and genetics, (3) Ecology, (4) Medical and Veterinary Entomology, (5) Economic Entomology with its subdivisions relating to forest, fruit, vegetable and cereal insects, bees, insecticides and appliances. According to the number of papers announced, each section may be subdivided or several sections may be united. Time will be arranged for an all-day visit to the Geneva Experiment Station where the forenoon will be spent in looking at the exhibit of spraying machinery and insecticides, in examining the methods and machinery used in controlling the European corn borer, and in observing a demonstration of airplane dusting. The afternoon will be devoted to a general program. In addition, the summer meeting of the New York State Horticultural Society will be held at Geneva on the same day. This will give visiting foreign entomologists more of an idea of the general interest of American

farmers in entomology. Certain afternoon excursions will also be made to nearby places of entomological interest, while immediately after the meetings some general excursions are planned to Niagara Falls, to entomological museums of eastern cities and to the laboratories of the U. S. Bureau of Entomology devoted to the study of the Gypsy and Browntail Moths, the European Corn Borer and the Japanese Beetle.

A record of unusual interest in relation to two leaders in entomological work is reproduced here. It is a tale of accomplishment we all admire, and an exposition of possibilities in scientific work.

After more than 33 years of service as chief entomologist of the United States Department of Agriculture, Dr. LELAND O. HOWARD retired October 17 as the chief of the Bureau of Entomology, and was succeeded by Dr. C. L. MARLATT, a member of the department since 1888, and who for the past five years has been associate chief in charge of the regulatory work of the bureau, and also chairman of the Federal Horticultural Board.

Dr. Howard is now in his fiftieth year of Government service, having joined the entomological branch of the Department of Agriculture in 1878 soon after his graduation from Cornell University. He retires as chief at his own request, but this does not mean retirement from service. He has passed his seventieth birthday, and has asked to be relieved of the administrative duties of his office, but proposes to devote his full energies to the field of entomological research in which he has long been recognized as perhaps the most distinguished investigator. His favorite fields are medical entomology and parasitology.

Dr. Howard was placed in charge of the entomological work of the department June 1, 1894. In the 33 years that have followed, the science of entomology has broadened tremendously and Dr. Howard has guided numerous activities which have been of great service to the American public.

Two campaigns with which Dr. Howard has been identified have captured the public fancy. He was a leader in the mosquito crusade. As early as 1892 he published results of experiments showing that certain types could be controlled by the use of kerosene, and when the mosquitoes were identified as disease carriers he was able to recommend methods of control. His publications on the house fly dating from 1896, to his book, The House Fly, Disease Carrier, in 1911, were largely responsible for the anti-house fly crusades all over the world in the last 20 years.

Dr. Howard is a member of the three great American associations of limited membership, the National Academy of Sciences, the American

Philosophical Society, and the American Academy of Arts and Sciences. He was Permanent Secretary of the American Association for the Advancement of Science for 22 years, and its president in 1920–21. He has been made honorary member of many foreign scientific societies and is the only American honorary member of the Academy of Agriculture of France, and received several decorations among which are the Cross, Chevalier de la Legion d'Honneur, and the Cross, Officer de l'Odre du Merite Agricole. He has been a delegate to many international assemblies and an officer of six scientific gatherings. In addition to bachelor's and master's degrees from Cornell, his doctorates include Ph.D. (Georgetown 1896), M. D. (George Washington, 1911), LL.D. (Pittsburgh, 1911), and Sc.D. (Toronto, 1920). The bibliography of his publications includes 941 titles.

Dr. Marlatt joined the Department of Agriculture in 1888 and has been closely associated with Dr. Howard's administration. When Dr. Howard was made chief Dr. Marlatt became assistant chief; and in 1922 associate chief in charge of regulatory work. He was instrumental in promoting the passage of the Plant Quarantine Act of 1912 and was appointed to administer it. Dr. Marlatt's specialties have been studies of scale insects, sawflies and periodical Cicadas, known as locusts.

He holds the degrees of B.S., M.S., and D.Sc., all from the Kansa State Agricultural College.

Obituary

FREDERIC LEONARD WASHBURN

PROFESSOR FREDERIC LEONARD WASHBURN, chief of the division of entomology and State Entomologist for Minnesota from 1902 to 1918, died suddenly from a combined attack of flu and pneumonia at his lake residence, Mound, Minnesota, Saturday, October 15, 1927.

Professor Washburn received his A.B. from Harvard in 1882 and his A.M. (Harvard) 1895. He was instructor in Zoology at Michigan 1887–1888. In 1888 he was called to Oregon where he became entomologist and state biologist. In May 1902, he came to Minnesota as successor to Otto Lugger. He continued the series of reports begun by his predecessor. These reports, 7–16, were well illustrated and a number contain beautifully colored plates.

From 1918 until his retirement from University work in 1926, Professor Washburn retained his connection with the Minnesota division of

entomology as economic zoologist. He was particularly interested in birds and mammals. During the late war he took an active interest in Belgian hares in order to help increase the food supply of the country. As a result of these activities he produced a book on rabbit farming.

During his sojourn in the South Sea Islands he made many paintings of native scenery and life on the Islands, besides making a collection of insects. Upon his return to this country he gave lectures on life in the Islands which were profusely illustrated by colored lantern slides. It was the artistic temperament showing through, and upon his retirement he immediately started devoting his time to painting, lecturing and writing. He was perfectly happy in this environment and it was expected that he would have many happy years in the work he loved so well.

F. L. Washburn was president of the American Association of Economic Entomologists for 1911. He is the author of "Injurious Insects and Useful Birds" and the "Rabbit Book," both published by Lippincott. He was the first entomologist in this country to figure and describe the egg of the codling moth.

Current Notes

Dr. David L. Crawford is now president of the University of Hawaii.

Entomological News announces the death on August 8, 1927, of Mr. G. C. Champion at Woking, England.

The Japanese Beetle Laboratory, Riverton, New Jersey, has been moved to more commodious quarters at Moorestown, New Jersey.

Mr. H. J. MacAloney returned August 25, after working for three months in Canada under Dr. J. M. Swaine of the Entomological Branch, on the white pine weevil.

Dr. T. J. Headlee recently visited the entomological field laboratory at Chatham, Ontario, and discussed the value of parasites in the control of the Oriental peach moth.

Mr. M. A. Stewart, a student of the Siphonaptera, and formerly instructor in biology at the University of Rochester, has been appointed instructor in biology at Rice Institute, Houston, Texas.

Sir Arthur Everett Shipley, Vice-Chancellor of the University of Cambridge, England, distinguished zoologist and entomologist and a foreign member of this Association, died on September 22, aged 66 years.

Mr. E. R. de Ong has recently resigned from the University of California and is now engaged as consulting entomologist and in teaching in the Cora Williams Institute, Berkeley, Calif.

At the Idaho University and Station, Mr. W. E. Schull will serve as assistant professor of entomology and extension entomologist during the absence of F. E. Whitehead, who is at the Iowa College for graduate study during the year.

According to *Science*, E. O. Essig has been appointed professor of entomology at the University of California and entomologist of the Agricultural Experiment Station. Dr. Edwin C. Van Dyke has also been appointed professor of entomology at the same institution.

Science also reports that Assistant Professor A. E. Emerson, of the department of zoology of the University of Pittsburgh, who represented the University at the International Congress of Zoologists at Budapest, has returned from a year's study in Italy and Sweden.

Mr. Harold Compere, an entomologist at the Citrus Experiment Station of the University of California, Riverside, Calif., visited the Honolulu station of the Bureau on August 5. Mr. Compere was on his way for an extended stay in Australia in search of beneficial insects.

Mr. A. B. Gahan, of the Bureau of Entomology, sailed from New York on September 13 for an extended trip to Europe to study the types of parasitic Hymenoptera and consult with other specialists on this group. He planned to stop first at the British Museum.

Mr. C. B. Hutchings supervised the display of entomological exhibits at the Central Canada Exhibition, Ottawa, August 22–27, and the Canadian National Exhibition, Toronto, August 27 to September 10. Mr. Hutchings was assisted by several officers from Branch headquarters and from the laboratories at Chatham, Vineland, and Strathroy.

Dr. M. W. Blackman returned on September 1 to the New York State College of Forestry at Syracuse University. He had been with the Bureau as specialist in Scolytidae for the preceding 15 months, engaged in biological studies of the Black Hills beetle on the Kaibab and Colorado National Forests.

Messrs. A. F. Burgess, H. L. Blaisdell, and E. B. O'Leary, of the Bureau of Entomology, and H. L. McIntyre, Supervisor Forest Pest Control for the State of New York, held a meeting at Pittsfield, Mass., on August 24 to discuss cooperative plans of gipsy moth work in the State of New York.

Recent visits to the Boyce Thompson Institute for Plant Research have been made by the following entomologists: Mr. E. A. Richmond of Riverton, N. J.; Dr. I. M. Hawley of Salt Lake City, Utah; Mr. V. I. Safro of New York City; Prof. Robert Matheson of Cornell University, and Dr. W. H. Thorpe of Cambridge University, England.

According to *Science*, a banquet was held by the Czecho-Slovak Academy of Agriculture on August 15 in honor of its visiting honorary member, Dr. L. O. Howard, of the U. S. Bureau of Entomology. During the banquet, Professor Stoklasa, who

acted as toastmaster, spoke in appreciation of Dr. Howard's contributions to entomology.

Mr. G. F. Moznette, in charge of the pecan insect laboratory of the Bureau of Entomology at Albany, Ga., attended the twenty-sixth annual convention of the National Pecan Growers' Association, held at Shreveport, La., on September 27–29, and delivered an address on "Factors Which Enter into the Successful Control of the Pecan Nut-Case Bearer."

Professor James G. Needham, head of the department of Entomology at Cornell University, has been granted sabbatical leave for the coming year and has sailed for China, where he will give a series of lectures on biological subjects at the Peking National University and Tsing Hua College, and an address at the opening of new buildings at the University of Yen Ching.

A conference of entomologists and commissioners of agriculture was held in the State House, Providence, R. I., on November 9, to consider certain phases of European corn borer control. The following entomologists were present: W. C. O'Kane, Durham, N. H.; R. H. Allen, Boston, Mass.; Harold L. Bailey, Bradford, Vt.; A. E. Stene and Harry Horovitch, Providence, R. I.; W. E. Britton, New Haven, Conn.; R. S. Clifton, Boston, Mass., and C. H. Hadley, Toledo, Ohio, of the Federal Bureau of Entomology.

Scouting for the European corn borer revealed that this insect is quite generally distributed in northern Ontario and southern Quebec. The infested area extends from St. Joseph's Island, Ontario, on the west to Batiscan Champlain County, Quebec, on the east. The most northerly collection was taken in Ontario near New Liskeard and Haileybury, in the Timiskaming district. Scouting in the provinces of Nova Scotia and New Brunswick failed to reveal any trace of the pest.

The new library at the Kansas State Agricultural College has recently been completed. Fairchild Hall, in which the library formerly was located, has been remodeled and improved facilities afforded for the Department of Entomology. A separate, advanced laboratory accommodating 12 graduate students, an enlarged collection room, three additional offices for the staff, and a general work room are the more important improvements. The lighting has been improved throughout, and most of the walls have been repainted.

Mr. H. G. Crawford returned to Ottawa from Western Canada on September 12, after visiting the laboratories at Lethbridge, Alta., Saskatoon, Sask., and Treesbank, Man., during the latter half of August and early September. En route, he conferred on entomological matters with Prof. E. H. Strickland of the University of Edmonton and Prof. A. V. Mitchener of the University of Manitoba. While in Winnipeg, he visited the Rust Research Laboratory. On September 23 he visited Professor Lawson Caesar at Guelph.

A conference was held on October 4 at the American Museum of Natural History in New York to discuss certain phases of the Japanese beetle quarantine. Entomologists present were: E. N. Cory, College Park, Md.; T. J. Headlee, New Brunswick, N. J.; H. B. Weiss, and V. I. Safro, Trenton, N. J.; W. C. O'Kane, Durham, N. H.; A. E. Stene, Kingston, R. I.; W. E. Britton and J. P. Johnson, New Haven, Conn.; E. P. Felt, Albany, N. Y.; and C. W. Stockwell, Riverton, N. J., C. H. Hadley,

Toledo, Ohio, and S. B. Fracker, Washington, D. C., representing the Bureau of Entomology.

Mr. E. G. Titus has resigned as Director of agricultural research with the Utah-Idaho Sugar Company, effective October 1, to accept a position as agricultural representative for the United States and Canada with the Dippe Brothers Seed Company of Quedlinburg, Germany. He expects to maintain headquarters at Salt Lake City with sub-stations in Colorado and Michigan and probably other points where experimental work will be carried on, to develop types of sugar beets and vegetables better adapted for the various sections and to endeavor to develop resistant types against the disease caused by Cercospora and other fungi, and against the curly leaf disease transmitted by the sugar-beet leaf-hopper, *Eutettix tenella* Baker, cooperating with all agencies possible.

The annual meeting of the International Great Plains Crop Pest Committee was held at the Dominion Entomological Laboratory at Saskatoon, Sask., August 31–September 1, under the chairmanship of Mr. Norman Criddle, and with Mr. K. M. King acting as secretary. Among those who attended the meetings were: R. A. Wardle of the University of Minnesota; J. A. Munro, entomologist of the Agricultural Experiment Station, Fargo, N. D.; N. C. Phillips and W. B. Mabee of the Agricultural Experiment Station, Bozeman, Montana; Stewart Lockwood of the Billings Laboratory, Montana; A. V. Mitchener of the University of Manitoba; E. H. Strickland of the University of Alberta, and S. H. Vigor of the Field Crops Branch, Regina. In addition to Mr. Criddle the following Branch officers also attended: Messrs. H. G. Crawford, H. L. Seamans, K. M. King, Eric Hearle, H. E. Gray, K. E. Stewart, N. J. Atkinson, E. McMillan and A. P. Arnason.

Mr. R. A. Cushman, of the U. S. National Museum, left for Los Banos, Philippine Islands, early in October, to pack and ship to this country the large collection of insects bequeathed to the U. S. National Museum by the late C. F. Baker. This collection is reported to include more than 1,450 Schmitt boxes of pinned specimens, a large quantity of unmounted material, and an extended card index of references to Indo-Malayan entomology. It contains many types and hundreds of species new to the National collection. No one in the Islands could undertake the task of packing this collection, and because of its importance and to comply with the expressed wish of Dr. Baker, the Bureau is cooperating with the Museum in arranging for its safe transport to Washington. In order that Mr. Cushman may properly represent the Museum, he has been appointed Honorary Assistant Custodian of Hymenoptera. It is expected that he will be away from Washington until early in January.

The Department of Entomology of the Kansas State Agricultural College has the following graduate students at the present time: Chester B. Keck, B. S., K. S. A. C., 1926, who is working on the tarnished plant bug, with special reference to alfalfa; Wesley G. Bruce, B. S., K. S. A. C., 1918, who holds the Volck research scholarship under the Crop Protection Institute, and is working on Volck as a control for certain external animal parasites; C. E. Abbott, A. B., Wisconsin University, 1925, who is majoring in Morphology and Physiology, and is studying the rice and granary weevils to see why they are so difficult to kill in fumigations; J. Forrest Garner, B. S., K. S. A. C., 1926, who is majoring in Apiculture and is studying various methods of field treatment of American foulbrood and wintering bees in Kansas; C. B. Wisecup,

B. S., K. S. A. C., 1926, also majoring in Apiculture and studying honey products; J. E. Durham, B. S., K. S. A. C., 1927, who is studying the ring-legged earwig recently found in numbers in flour mills in Kansas, and George B. Wagner, who will finish the B. S. work February 1. There are also five other graduate students from other departments minoring in some phase of Entomology.

The Fourth Annual Conference of Connecticut Entomologists was held at the Agricultural Experiment Station, New Haven, on November 4. Forty-three were present. The following program was carried out: Present Organization of Entomological Work in Connecticut, by Dr. W. E. Britton, New Haven; A Contribution to Our Knowledge of Cucumber Beetles, by Dr. H. C. Huckett, Riverhead, N. Y.; Notes on the Life History of the Asiatic Beetle, by Dr. R. B. Friend, New Haven; A General Survey of Gipsy Moth Conditions, by A. F. Burgess, Melrose Highlands, Mass.; Gipsy Moth Conditions in Connecticut, by John T. Ashworth, Danielson; Spread of the European Corn Borer and the Establishment of Imported Parasites, by D. W. Jones, Arlington, Mass.; Present Status of the European Corn Borer in Connecticut, by M. P. Zappe, New Haven; The Japanese Beetle and the Parasites Which Have Been Established in This Country, by J. L. King, Moorestown, N. J.; Japanese Beetle Conditions in Connecticut, by J. Peter Johnson, New Haven; Some Notes on the Life History, Habits, and Methods of Control of *Aserica castanea*, by Prof. C. C. Hamilton, New Brunswick, N. J.; The Plum Curculio in Connecticut Apple Orchards, by Dr. Philip Garman, New Haven; Mosquito Elimination Work of the Season in Connecticut, by R. C. Botsford, New Haven.

Dr. S. P. Minkiewicz, entomologist of the Institute for Agricultural Research, Pulawy, Poland, spent the week of October 19–24, visiting the Division of Entomology at the University of Minnesota. Dr. Minkiewicz was especially interested in the studies in insect ecology being carried on at Minnesota and in examining the laboratory and apparatus for studying the reactions of insects under controlled temperature and humidity conditions.

Dr. R. N. Chapman, who has been in Europe for the past year on a Guggenheim fellowship, has returned to the United States and resumed his duties with the Division of Entomology at the University of Minnesota. While in Europe Dr. Chapman spent the greater part of his time in studies on the "Biotic Potential of Insects." He also had the opportunity of visiting a large number of institutions in Europe where Entomology is taught or where research work is carried on.

Mr. F. G. Holdaway of Adelaide, Australia, is spending the year of 1927–28 at the Division of Entomology, University of Minnesota, studying for an advanced degree.

Mr. Stanley Garthside, of Sydney, Australia, who has been studying for the past year on a fellowship in Forest Entomology, is spending the current year at the Division of Entomology, University of Minnesota.

Mr. Lucius B. Reed, a graduate of the Department of Entomology, Clemson College, South Carolina, has been appointed an assistant in the Division of Entomology, University of Minnesota, and is also studying towards an advanced degree.

Mr. L. W. Orr has been appointed instructor in the Division of Entomology at the University of Minnesota and will teach the classes in forest entomology at that station.

Mr. H. E. Gray of Lethbridge, Alberta, has been appointed an assistant in the Division of Entomology, University of Minnesota, and is also studying at that station for an advanced degree.

Mr. R. E. Ozburn of the department of entomology, Ontario Agricultural College, Guelph, Ontario, is studying for an advanced degree in the departments of Zoology and of Entomology at the University of Minnesota during the current year.

Mr. E. G. Reinhard has accepted a position with the Minnesota Board of Public Health and will be engaged in a study of the insects inhabiting the lakes of Minnesota in connection with a survey being carried on by the public health board. Mr. Reinhard is also carrying work towards an advanced degree in the departments of Zoology and of Entomology at the University of Minnesota.

Mr. Allen McIntosh has resigned his assistantship in Zoology at the University of Minnesota and has accepted a position with the Department of Zoology at the University of Wyoming.

Dr. S. A. Graham has resigned his position as Assistant Professor of Forest Entomology at the University of Minnesota and has accepted a position as Associate Professor of Forest Entomology at the University of Michigan. Dr. Graham will be connected with the new school of forestry at that institution.

Professor J. S. Houser, Director of the Department of Entomology, Ohio Agricultural Experiment Station, Wooster, Ohio, visited the Division of Entomology of the University of Minnesota, November 5 to 8, inspecting the laboratories for the control of temperature and humidity in connection with the studies of insect ecology.

Mr. H. L. Seamans of Lethbridge, Alberta, visited the Division of Entomology of the University of Minnesota, November 5 to 8, and conferred with various members of the department regarding problems in entomological research.

Apicultural Notes

The fall meeting of the Connecticut Bee-Keepers Association was held at the State Capital, Hartford, on October 15. The principal speakers were R. B. Willson, Allen Latham, and Rev. A. W. Canney.

Messrs. C. B. Keck, Forrest Garner, and C. B. Wisecup, graduates of the Kansas State Agricultural College, 1926, are specializing in apiculture in the Department of Entomology at the Kansas State Agricultural College.

The annual meeting of the American Honey Producers' League will be held in San Francisco, California, on January 25, 26 and 27. In connection with this meeting there will be inaugurated an annual national honey exposition.

An item of economic interest is the recent great increase in the exportation of honey. This increase parallels the recent activities of various governmental agencies in promoting foreign trade in honey. During the fiscal year ending June 1926, only about three million pounds of honey was exported as against about eleven million pounds for the year ending June 1927.

A cooperative honey marketing association has been formed in Ohio, based on one of the commercial beekeepers' associations. As the members of this association

have been working together for a long time, not having missed a monthly meeting in ten years, the new organization should be successful. All the honey sold by the association will be graded according to the United States grades.

Mr. James I. Hambleton, of the Bee Culture Laboratory of the Bureau of Entomology, attended the meetings of the Louisiana State Beekeepers' Association held at New Orleans on November 14 and 15. He also inspected the flood relief work done in the interest of Louisiana beekeepers. Beekeepers from the North have aided beekeepers in the flooded regions by donating packages of bees. The express companies transported these donations free of charge. The American Red Cross also made cash funds available for the beekeeping relief work.

The Bee Culture Laboratory, of the Bureau of Entomology, in using the Standard Honey Color Grader, has found that washing the honey trough after grading a sample is greatly facilitated by using a dam of rubber to confine the honey to the part of the trough required for that particular sample, thus keeping the honey out of the narrow end of the wedge, which is the difficult part to cleanse, the narrow part being required only for the darker honeys. Pieces of rubber cut from an ordinary eraser answer the purpose excellently.

Dr. W. W. Alpatov, of the University of Moscow, one of the outstanding apicultural workers of Russia, is in this country pursuing his work on variability in the honeybee. He is particularly desirous of continuing his work on variability in this country because of the same distinct advantages offered in the United States, as in Russia, by the great range in latitude. The work here is being done with Professor Raymond Pearl of the Institute for Biological Research at Johns Hopkins University. During the past summer Dr. Alpatov was at Cornell University with Professor E. F. Phillips.

Mr. Lloyd M. Bertholf, Professor of Biology at Western Maryland College, has been granted leave of absence to study at Johns Hopkins University, where he has been awarded the Bruce fellowship. He will continue his work on the reaction of the honeybee to light of varying intensity and color. During the past summer he has been employed as a temporary Junior Biologist in Apiculture at the Bee Culture Laboratory of the Bureau of Entomology. A recent issue of the *Journal of Agricultural Research* contained a paper by Professor Bertholf entitled "The Utilization of Carbohydrates as Food by Honeybee Larvae." This paper is based on work done at the Bee Culture Laboratory during a previous summer. Professor E. F. Phillips of Cornell University, in the same issue of this journal, also has a paper which deals with the utilization of carbohydrates by the adult honeybee.

Notes on Medical Entomology

According to *Science*, the Harben gold medal of the Royal Institute of Public Health has been awarded for 1928 to Sir Ronald Ross in recognition of his eminent services to public health.

Mr. F. C. Bishopp has been transferred from Dallas, Texas, to Washington, D. C., and placed in charge of the experimental work on insects affecting man and animals. Mr. E. W. Laake has been placed in charge of the Dallas laboratory.

Professor R. A. Cooley spent a few days in Washington during early November conferring with various officials relative to his work on the Rocky Mountain spotted fever tick problem and especially that phase of it relating to the propagation of tick parasites.

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